

THE EFFECTS OF VISITOR PERCEPTIONS AND ENCODING CUES ON
LEARNING FROM MUSEUM EXHIBITS

By

JOHN SCOTT FOSTER

A DISSERTATION PRESENTED TO THE GRADUATE SCHOOL
OF THE UNIVERSITY OF FLORIDA IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY

UNIVERSITY OF FLORIDA

1992

Copyright 1992

by

John Scott Foster

ACKNOWLEDGMENTS

I would like to extend my gratitude to Drs. John J. Koran, Jr., Mary Lou Koran, John F. Eisenberg, Linda Jones, and Eugene Todd for their support throughout the development of this dissertation. Their advice, encouragement, and patience has been invaluable.

This dissertation would not have been realized without the help provided by my friends and fellow graduate students. I would like to extend my thanks to those that have contributed their skills, undergraduate classes, resources, and moral support over the past years: Dan Lofald, Dan Pearson, Paul Andreadis, Harriet Landers, Ann Donnelley, Catherine Urquhart, Kenny Cyrus, and Jim Ellis. I would like to also acknowledge the late Dr. Robert Jester for his help in establishing test reliability and providing his students as subjects for the project.

I would like to thank my parents, Mr. and Mrs. James E. Foster, who have provided continued support and encouragement, as well as generous grants, while waiting patiently for their son to become Dr. John Scott Foster. I would also like to thank Mr. and Mrs. Fred Goldsmith for their contribution to this undertaking.

And most of all, I wish to acknowledge my wife, Karin, for hours of editing and unending enthusiasm, support, and understanding over the past 4 years.

TABLE OF CONTENTS

	<u>page</u>
ACKNOWLEDGMENTS.....	iii
LIST OF TABLES	vi
LIST OF FIGURES	ix
ABSTRACT	x
CHAPTERS	
1 INTRODUCTION	1
Purpose.....	1
Background to the Problem.....	1
Summary.....	5
2 REVIEW OF THE LITERATURE.....	6
Informal Learning Centers: An Overview	6
Visitor Attention and Learning from Exhibits.....	6
The Effect of Learner Perceptions on Achievement.....	14
The Effect of Encoding Cues on Achievement.....	17
Aptitude Treatment Interactions and Learning in Informal Settings	22
Summary.....	29
Hypotheses.....	29
3 MATERIALS AND METHODS.....	31
Subjects and Treatment Groups	31
Materials.....	32
Measures	32
General Procedure.....	34
Statistical Analyses.....	35

4	RESULTS.....	36
	Research Questions	36
	Variables.....	37
	Subject Report of Effort Expended on Task	41
	Time on Task	43
	Subject Report of Task Difficulty	45
	Posttreatment Museum Demand Characteristics	48
	Total Test Score	52
	Scores on High Level Subtest	53
	Scores on Low Level Subtest.....	54
	Summary of Results	59
5	DISCUSSION AND CONCLUSION	61
	Perceived Museum Demand Characteristics, Effort, and Time on Task	61
	Effect of Instructions.....	67
	Aptitude Treatment Interactions.....	69
	Conclusion and Implications for Future Research.....	71
	GLOSSARY	77
	APPENDICES	
	A MATERIAL FOR TEXT TREATMENT GROUP.....	78
	B MUSEUM DEMAND CHARACTERISTICS TEST AND SELF REPORT ITEMS	93
	C ACHIEVEMENT TEST.....	95
	D R-SQUARED VALUES FOR ALL SIGNIFICANT MODELS	102
	E MULTIPLE REGRESSION SUMMARY TABLES FOR MAIN EFFECTS	103
	F MULTIPLE REGRESSION SUMMARY TABLES FOR TREATMENT EFFECTS.....	108
	G MULTIPLE REGRESSION SUMMARY TABLES FOR APTITUDE TREATMENT INTERACTIONS.....	113
	REFERENCES.....	119
	BIOGRAPHICAL SKETCH.....	124

LIST OF TABLES

Table	Page
3-1. Reliability of Museum Demand Characteristics Test and Achievement Tests	35
4-1. Aptitude Data	38
4-2. Correlations between Hidden Figures Test, Associative Memory, Verbal Fluency, and Total Test Score.....	39
4-3. Outcome Data.....	40
4-4. Means and Standard Deviations regarding Subject Report of Museums as Fun.....	41
4-5. Descriptive Statistics for Museum Demand Characteristics X Treatment Interactions for Subject Report of Invested Effort	42
4-6. Descriptive Statistics regarding Effort X Treatment Interactions for Time Spent on Task.....	45
4-7. Summary of Main Effects.....	46
4-8. Descriptive Statistics regarding Time on Task X Treatment Interactions Regarding Perceived Task Difficulty.....	48
4-9. Descriptive Statistics for Treatment Effects and Aptitude X Treatment Interactions Regarding Posttreatment Museum Demand Characteristics	52
4-10. Descriptive Statistics for Treatment Effects Regarding Low Level Subtest Score	57
4-11. Descriptive Statistics for Aptitude X Treatment Interactions Regarding Low Level Subtest Score	58
5-1. Variation in Experimental Relationships as a Function of Test and Predictor Variable	74
E-1. The Effect of Museum Demand Characteristics (MDC) on Perceived Difficulty of Task.....	103
E-2. The Effect of Verbal Fluency on Total Test Score.....	103
E-3. The Effect of Associative Memory on Total Test Score.....	104

E-4. The Effect of Hidden Figures Score on Total Test Score.....	104
E-5. The Effect of Time on Total Test Score.....	104
E-6. The Effect of Hidden Figures Test Score, Verbal Fluency, and Associative Memory on Total Test Score.....	105
E-7. The Effect of Hidden Figures Score on High Level Subtest Score.....	105
E-8. The Effect of Verbal Fluency on High Level Subtest Score.....	105
E-9. The Effect of Subject Task Preference on High Level Subtest Score	106
E-10. The Effect of Hidden Figures Test Score, Verbal Fluency, and Associative Memory on High Level Subtest Score.....	106
E-11. The Effect of Time on Task on Low Level Subtest Score.....	107
F-1. The Effect of Treatment on Time on Task.....	108
F-2. The Effect of Treatment on Low Level Subtest Score.....	109
F-3. The Effect of Treatment on Low Level Subtest Score, Controlling for Verbal Fluency	110
F-4. The Effect of Treatment on Low Level Subtest Score, Controlling for Associative Memory	111
F-5. The Effect of Treatment on Low Level Subtest Score, Controlling for Hidden Figures Test Score.....	112
G-1. The Interaction between Museum Demand Characteristics (MDC) and Treatment on Subject Report of Effort Expended on Task.....	113
G-2. The Interaction between Subject Report of Effort Expended on Task and Treatment on Time Spent on Task.....	114
G-3. The Interaction between Time Spent on Task and Treatment on Subject Report of Task Difficulty	115
G-4. The Interaction between Subject Report of Effort Expended on Task and Treatment on Posttreatment Museum Demand Characteristics	116
G-5. The Interaction between Pretreatment Museum Demand Characteristics (MDC) and Treatment on Posttreatment Museum Demand Characteristics	117
G-6. The Interaction between Task Preference and Treatment on Low Level Subtest Score.....	118

LIST OF FIGURES

Figure	Page
4-1. The interaction between museum demand characteristics and treatment on subject report of effort expended on task.....	43
4-2. The interaction between effort and treatment on time spent on task.....	44
4-3. The interaction between time on task and treatment on perceived task difficulty	47
4-4. The interaction between effort and treatment on posttreatment museum demand characteristics (MDC)	50
4-5. The interaction between pretreatment museum demand characteristics and treatment on posttreatment museum demand characteristics	51
4-6. The effect of treatment on low level subtest after controlling for verbal fluency.....	56
4-7. The interaction between task preference and treatment on low level subtest score	58

Abstract of Dissertation Presented to the Graduate School
of the University of Florida in Partial Fulfillment of the
Requirements for the Degree of Doctor of Philosophy

THE EFFECTS OF VISITOR PERCEPTIONS AND ENCODING CUES ON
LEARNING FROM MUSEUM EXHIBITS

By

John Scott Foster

May 1992

Chairman: Dr. John J. Koran, Jr.
Major Department: Instruction and Curriculum

This study investigated the effect of (a) visitors' perceptions of museums on time spent on learning; (b) media and task instructions on achievement; (c) task difficulty on effort invested in learning from exhibits; and (d) verbal ability, disembedding ability, associative memory and task preference on achievement as a function of treatment.

The study incorporated four treatment groups. Three treatment groups viewed a series of museum exhibits; however, each treatment group received different task instructions. The fourth treatment group read an exhibit transcript. One hundred sixty-seven subjects recruited from undergraduate education courses were randomly assigned to treatments. Achievement was measured with a test composed of 29 recall and recognition items and eight synthesis, application and analysis items. All hypotheses were tested at the .05 significance level.

There was no positive relationship between subjects' perceptions of the amount of work involved and effort invested in learning for any treatment group. A positive

relationship between amount of invested effort and time on task was only noted for subjects who were instructed to summarize each exhibit's content. There was no relationship between subjects' perceptions of the amount of work involved or amount effort invested in learning and achievement. Results indicated the time on task, hidden figures test score, task preference and verbal fluency were significant predictors of success in learning from museum exhibits. Interactions were noted between treatment and task preference and time on task for the low level subtest.

Implications of this study are (a) that individual interests and internally set learning goals of visitors may result in visitors bypassing exhibits deemed too difficult, rather than investing more effort in learning; (b) simple instructions can significantly affect achievement; and (c) learner aptitudes can significantly affect achievement.

CHAPTER 1 INTRODUCTION

Purpose

This study had four objectives: (a) to examine the effect of visitors' perceptions of museums on time spent on learning, effort invested in learning and the relationship between effort and achievement; (b) to investigate the effect of method of information presentation on achievement; (c) to examine the effect of encoding cues on achievement, (d) to ascertain the effect of task difficulty on mental effort invested in learning from museum exhibits; and (e) to investigate the interaction between treatments and learner characteristics such as verbal ability, disembedding ability, associative memory, and task preference in relationship to achievement.

Background to the Problem

Education has traditionally been viewed as taking place in a classroom. However, estimates suggest that only approximately 30 % of the learning that takes place in the classroom can be attributed to variables in the formal school environment (Gage, 1978). Clearly, considerable learning occurs outside the formal classroom environment. Learning in informal settings, such as museums, zoos, science centers, and field trip experiences, has assumed an increasingly important role in augmenting classroom instruction for school age students and for adults pursuing continuing education. Despite its large role in education, a complete understanding of learning in informal settings has remained problematic.

Because the first step in learning is attending to a stimulus, a large number of studies on learning in informal settings have been carried out to determine exhibit characteristics that maximize attention, or as museologists refer to it, attracting and holding power (Koran, Longino, & Shafer, 1983). Researchers have examined the effects of elements such as visual attractiveness, length of labels, and intensity of illumination on the attracting and holding power of exhibits (Falk, Koran, Dierking, & Dreblow, 1985). Findings from this line of research have clearly demonstrated that manipulation of exhibit characteristics can result in increased attracting and holding power. However, holding power is rarely increased to a level where visitors attend to exhibits long enough to read all of the textual material (Peart, 1984). The relatively low holding powers reported, independent of exhibit characteristics, make it difficult to infer that significant learning occurs in informal settings.

Although visitor behavior is affected by exhibit characteristics, learning may be more a function of visitor characteristics. The visitor characteristic that has been predominant in literature dealing with learning in informal settings is visitor preparation. Positive learning outcomes have been associated with four situations: (a) when visitors were given previsit instructions that provided background knowledge and learning strategies which facilitated comprehension of exhibits; (b) when congruence between visitor knowledge and exhibit content existed; (c) when questions were presented to guide visitors to salient features of an exhibit; and (d) when exhibits were designed with consideration of the visitor's cognitive ability (Koran et al., 1983). Thus, one objective of this study was to inquire as to the effect that simple instructions would have on achievement in a museum setting.

One visitor characteristic that may have a significant effect on learning in informal settings, independent of exhibit characteristics and visitor cognitive ability, is the amount of effort that an individual devotes to what is to be learned. Salomon (1983), in an exploration of learning from television versus print, noted that learner

perceptions of an information source (e.g., television, text, lecture, and museum exhibit), perceptions of the task to be carried out, and perceived efficacy of learning from a particular information source had profound effects on the amount of mental effort an individual invested in a task. Individuals who perceived a task or information source as entertaining, fun, easy, or unrealistic were less likely to invest a great deal of mental effort. Conversely, individuals who perceived an information source or task as realistic or difficult were more likely to invest a greater amount of mental effort into the task. Increasing the amount of mental effort invested in a task is likely to result in increased elaboration and integration of information into an organized schema. Thus, knowledge gain was a function of the interaction of the subject's perceptions of the information source and the tasks to be performed.

Examination of visitor perceptions of informal learning centers indicates that most visitors view these centers more as a means of entertainment than as a learning experience (Kellert, 1979). Given that visitors perceive museums as fun and entertaining, it could be predicted that very little effort would be invested in learning from informal settings and, subsequently, very little learned. This would imply that efforts to change subjects' perceptions of informal learning centers may ultimately be more productive than changing the exhibits. In order to explore the relationship between individual perceptions and achievement, one objective of this study was to determine the impact of perceived demand characteristics of museums on learning from museum exhibits.

One method to increase the amount of mental effort that is invested in learning in informal settings may be through the provision of tasks which the visitor would perceive as difficult. Researchers studying learning from television, text, and lecture have noted that the provision of encoding instructions can change learners' perceptions of task difficulty. Glover, Plake, and Zimmer (1982) noted that "difficult initial processing implies more extensive or elaborate analysis and that this more extensive

analysis is reflected in a richer, more extensive memory record" (p 191). They also observed that distinctiveness of encoding of an event is determined in part by the operations a person carries out and not by the materials themselves. The recall of individuals who received specific instructions concerning task requirements was significantly improved, both qualitatively and quantitatively, when compared to the recall of individuals who did not receive instructions. Annis (1985) noted that not only did the individuals who received instructions recall more, but were able to successfully answer questions that involved making inferences and drawing logical conclusions derived from but not explicitly stated within the text.

The relationship among instructions, encoding, and cognitive gains has been replicated in research examining learning from television, lecture, and text, which incorporated a variety of instructional prompts (Field & Anderson, 1985; Peper & Mayer, 1986). It could be hypothesized that if instructions served to increase the learners perceived demands of the task, then when the learner is directed to meet certain criteria or carry out specific tasks, the task is perceived as being more difficult. The learner subsequently invests more effort into the task at hand which is positively associated with achievement. In informal learning settings the provision of instructions for tasks that are believed to be difficult, as opposed to simply looking at the exhibit, may compensate for visitor perceptions of museums as entertaining and result in increased amounts of effort being invested in learning. Thus, a third objective of this study was to examine the effect of treatment difficulty on mental effort invested in the task.

Achievement in informal learning centers may be due to more than the factors of visitor perceptions of the source of information and how the learner is directed to use the information. The effect of general ability on achievement in formal and informal settings has been emphasized in numerous studies (Koran & Koran, 1975, Shirey & Reynolds, 1988). The ability to distinguish relevant information from an irrelevant

background, restructure this information into manageable "chunks," and deal with verbally complex questions that call for problem solving skills, has also been positively related to achievement (Carter, LaRussa, & Bodner, 1987; Chandran, Treagust, & Bodner, 1987; Pribyl & Tobin, 1987; Staver & Jacks, 1988). Also, it could be hypothesized that an individual's ability to hold increasing amounts of information in short term memory is likely to be related to variation in achievement in informal settings. Consequently, it could be hypothesized that these abilities would play a more important role in predicting achievement when task instructions focus the individual toward learning goals which call for the careful processing of exhibit content. Thus, a fourth objective of this study was to investigate the interaction of the aforementioned aptitudes with the treatments when examining learning in museum contexts.

Summary

As informal learning centers are recognized as an important component of an individual's overall intellectual development, it is of increasing importance that the effectiveness of these centers be maximized. Although a great deal of research has been carried out which focused on exhibit attracting and holding power, little data are available on the direct relationship between exhibit characteristics and learning. Researchers examining learning from television, text and lecture have shown that visitor perceptions of the information source and tasks to be carried out can have a significant effect on learning. However, the effect of these variables on learning in informal settings has not been examined. Research, therefore, is needed to discern how the following factors affect learning in an informal setting: learner perceptions of the information source, tasks to be carried out with the source, and learner abilities.

CHAPTER 2 REVIEW OF THE LITERATURE

Informal Learning Centers: An Overview

Museums, zoological parks, and science and technology centers all maintain a common goal of providing learning experiences for visitors. These centers also have a number of other characteristics in common which set the parameters for informal learning settings. Compared to learning in formal environments, informal learning settings can be described by providing free choice, intrinsic motivation and self-directed activities where time and sequencing patterns of attention vary with characteristics of the learner and the exhibits. Organizations that may be considered informal learning centers also vary widely in terms of what is curated and how objects are interpreted. Art museums, history museums, science and technology centers, natural history museums, zoological parks, and aquaria all provide distinct experiences, yet all are informal learning centers. The importance of understanding how learning occurs in informal settings has generated a great deal of research. Given the variety of institutions which can be classified as informal learning centers and the variation in visitor behavior at these centers, integration of the literature into generalizable rules or concepts is a challenging undertaking.

Visitor Attention, and Learning from Exhibits

Much of the current research has been conducted under the assumption that a major objective of visitors in an informal learning center is to learn

(Koran Koran, & Longino, 1986). Visitor attention to a stimulus is seen as the first step in learning. Consequently, the majority of research carried out in informal settings has focused on visitor attention to exhibits. Here, researchers have sought to identify exhibit characteristics that maximize an exhibit's ability to attract visitors and the duration of time that the visitors attend to the exhibit.

The holding power of an individual exhibit tends to be quite brief. Both modal frequencies for skewed distributions and means for normal distributions of frequencies of time spent at an exhibit tend to be no greater than two minutes with means and modes as low as 10 seconds (Abrahamson, Gennaro, & Heller, 1983b; Beer, 1987; Brennan, 1977). Similar holding powers have been reported for zoological parks, observatories, aquaria and museums despite the differences in these institutions (Beer, 1987; Bitgood & Benefield, 1987; Brennan, 1977; Diamond, 1986; Koran, Koran, & Longino, 1986). Although low holding powers are the norm for exhibits, some degree of variation does exist. This variation is a function of idiosyncratic aspects of the visitor and systematic variation in exhibits (Beer, 1987; Koran et al, 1983).

Researchers investigating attracting and holding power of exhibits have presumed that the major determinant of visitor behavior is quality and content of an exhibit. Variables manipulated in research examining exhibit effectiveness include physical characteristics such as the visual attractiveness of an exhibit; length of labels; size of label type; and presence or absence of visual, aural, or tactile components. Information derived from studies of attention and visitor behavior have provided essential baseline information concerning behavior patterns at informal learning centers, behavior at individual exhibits, and the effects of exhibit style and characteristics.

Exhibit characteristics that have been reported to affect attracting and holding power are those that involve text presentation, exhibit illumination, and

inclusion of components which increase visitor sensory involvement. Of the research exploring the effect of enhanced sensory involvement, tactile interaction with an exhibit has been the most frequently manipulated variable. The ability to manipulate objects has been demonstrated to significantly increase the attracting and holding power of exhibits in a number of settings (Abrahamson, Gennaro, & Heller, 1983a; Abrahamson, Gennaro, & Heller, 1983b; Beer, 1987; Bitgood, Pierce, Nichols & Patterson, in press; Diamond, 1986; Koran, Koran, & Longino, 1986; Koran, Morrison, Lehman, Koran, & Gandara, 1984; Peart, 1984). Questions focusing visitors on salient features of the exhibit have also been reported to increase the holding power of exhibit labels (Serrell, 1981b). Minimizing exhibit wordage has also been positively related to exhibit attracting and holding power along with incorporation of content that is increasingly concrete in nature (Bitgood, Nichols, Pierce, Conroy, & Patterson, 1986; Serrell, 1981a; Serrell, 1981b).

In summary, exhibit attracting and holding power can be increased significantly by increasing viewer sensory involvement. Label and sign attracting and holding power can be increased via careful consideration of the quantity and quality of the label text. However, further examination of research on exhibit holding power and learning as a function of exhibit characteristics makes the effectiveness of these changes questionable.

Researchers investigating exhibit effectiveness often systematically vary one or two aspects of a particular exhibit. Rather than only reporting the amount of time a visitor spends in front of an exhibit, exhibit holding power is also reported as a distinct measure. Holding power is calculated by dividing the time devoted to an exhibit by the total time needed to view and read all of the components within an exhibit. Few studies report holding powers that would allow the visitor enough time to read all of the label content. Bitgood, Pierce,

Nichols, and Patterson (1987) were able to vary holding power in a walk through cave exhibit from approximately 50 seconds up to 200 seconds. However, the time needed to read the adjuncts to the cave exhibit was reported to be between 22 and 30 minutes. Peart (1984) was able to increase attracting power by 30% in an exhibit concerning colonial nesting sea birds through the addition of an audiotape of bird vocalizations. The holding power, however, was never greater than 18 seconds under any condition. Baseline time for viewing the entire exhibit was calculated to be 23 seconds. Serrell (1981b) reported significant increases in attracting and holding power when signs at the Brookfield Zoo were designed to guide attention and promote visitor involvement. Visitors who read labels in this study were defined as anyone who looked at the label for longer than 5 seconds. The time required to read the entire label was 30 seconds. Given the relatively low holding powers reported in research, it could be hypothesized that significant learning is not occurring in informal learning centers as a result of exhibit holding power.

Bitgood et al. (1986) and Peart (1984), measured visitor attention and achievement after systematically varying the characteristics of a single exhibit. In both cases, the researchers failed to note a positive relationship between attention and achievement. Bitgood et al. (1986), in an investigation of the effect of label characteristics on casual visitor behavior, reported significant increases in holding power by varying the number of words in a label, type size within the label and proximity of labels to the exhibit. No significant differences were noted in visitor achievement across any condition, despite the variation in holding power. Peart (1984), investigating the effect of increased sensory involvement on attracting and holding power, knowledge, and attitude change in casual visitors, noted trends similar to Bitgood et al. (1986). The exhibit incorporated in the research was varied such that it consisted of the label only,

the objects only, the label and objects, a picture of the label and objects, or label, objects and audio components. Increased sensory involvement resulted in increased attracting and holding power. However, increased holding power did not result in a significant increase in achievement.

Although visitor attention is the first step in learning from exhibits, learning may be more a function of what the visitor arrives with, rather than what the visitor is exposed to in an informal learning center. Consistent with this line of investigation, this study focused primarily on visitor characteristics and did not manipulate exhibit characteristics.

Koran, Koran, and Foster (1988) suggested that researchers investigating learning in informal settings need to take into account more than exhibit characteristics. Desired outcomes, visitor processing activities, and characteristics of the visitor must be taken into consideration to study learning outcomes accurately. Researchers who have demonstrated that learning does occur in informal learning centers have incorporated visitor characteristics into their research protocol. Examining the research which reports on visitor achievement is facilitated by dividing the literature into research that examined learning on the part of school groups and learning on the part of casual visitors to informal learning centers. This division is crucial in making generalizations concerning learning in informal settings.

The key differences between school groups and casual visitors lie in the ability to manipulate the amount of prior knowledge and the amount of structure that can be imposed upon the visit. Because of the attention to prerequisite knowledge and imposition of structure, there may be an increased "fit" between visitor objectives and exhibit objectives for school groups. Another consideration in examination of the literature concerning learning in informal learning centers is whether or not research subjects were aware of a posttest of

achievement before they viewed the exhibit(s). Externally imposed task parameters have been demonstrated to significantly affect learner perceptions of a task and subsequent behavior (Fire, 1985; Salomon, 1983; Shirey & Reynolds, 1988). These effects will be discussed in depth later in the review of the literature.

Researchers reporting significant learning by individuals in school groups as a result of a visit to an informal learning center have all noted some instruction prior to exposure. This instruction served to provide knowledge necessary to comprehend exhibit content and focus learner attention on salient features of exhibits. For example, Linn (1980) noted that changes in 12 year olds' scientific reasoning ability as a function of exposure to a free choice learning environment (Lawrence Hall of Science) was maximized when students received instruction prior to the visit. Provision of previsit instruction also resulted in students being more task oriented, focusing more attention on the task at hand, and investing more effort in the museum activities in which they participated.

Other studies involving more than six hours of instruction prior to a visit to an informal learning center have also reported significant increases in knowledge (Gennaro, 1981; Kolar, 1980; Wright, 1980). All of these researchers have confirmed, to a greater or lesser degree, the efficacy of including a visit to an informal learning center in science curricula. However, the major point here is that instruction prior to visiting an informal learning center for instruction must occur if desired cognitive goals are to occur.

Significant learning from museum exhibits has been demonstrated to occur by school children with a relatively minimal amount of prior instruction (Dierking, Koran, Lehman, & Koran, 1984; Fire, 1985; Koran, Lehman, Shafer, & Koran, 1983a). For example, Koran, Lehman, Shafer, and Koran,

(1983a), investigating the effects of pre- and postattention directing devices on learning from a museum visit, reported a trend which followed Linn's (1980) findings. Instruction was provided by a panel whose objective was to focus visitor attention and identify and explain ecological concepts and relationships. Students were instructed to study the panel and they were aware that a test would follow. Here, students given instruction to study the panel prior to examining a walk-through cave exhibit learned more than those receiving instruction after exposure and those who did not view the exhibit. Koran et al. (1980) postulated that information provided by the panel before exposure to the exhibit served to increase visitor attention and learning by focusing visitors on salient features and concerns of the exhibit. Similarly, Feher and Rice (1985) noted that young children who observed teachers interacting with hands-on exhibits concerning light and vision were not able to explain what they had observed. However, when the children received specific questions that guided them toward the correct interpretation, they were able to explain the phenomena.

Investigation of learning in informal learning centers which incorporate school groups as subjects has demonstrated the efficacy of providing instruction prior to a visit and called attention to subject cognitive abilities in order to maximize cognitive gains. Given the dynamics of a casual visit to an informal learning center, research involving casual visitors as subjects has focused on characteristics other than prior knowledge and focused on provision of structure for the casual visitor.

In an evaluation of exhibit effectiveness, Screven (1974) found that significant learning only occurred under very specific conditions. Visitors exhibited little if any learning from exhibits, unless they were made aware of exhibit objectives and their attention was focused on salient features of the exhibit. Greenglass's (1986) research carried Screven's (1974) work one step

further by examining the interaction of visitor ability with attention cues and learning goals. Greenglass systematically varied the amount of structure provided for the visitor. The high structure condition was quite similar to the conditions under which Screven noted that significant learning occurred; exhibit goals were communicated to the visitor and cues that focused visitors toward salient features were provided. Subjects in the low structure treatment were not provided with prompting cues. Results of the research indicated an interaction, with low ability subjects benefiting most from the presence of attention cues and high ability subjects performing best without attention cues. These findings were similar to conclusions derived from the Cronbach and Snow's (1981) review of aptitude treatment interaction literature, and emphasize the need to consider visitor ability in exhibit design and in studies of learning in informal learning centers.

Research examining learning in informal learning centers has varied greatly in subject populations, treatments, instrumentation, and success or failure in demonstrating significant learning outcomes. Instructional orientation has been demonstrated to be a crucial factor in ensuring that learning in informal learning centers occurs. The intensity of instructional orientation has varied greatly, from hours of previsit instruction to simply providing visitors with questions that guide them during their visit. Along with providing learning goals for the visit, provision of instructional orientation may also affect the visitors' perceptions of the amount of effort they need to invest in learning in informal settings. It is with this in mind that achievement was investigated in regard to subjects' perceptions of the demands of informal learning settings in this study.

The Effect of Learner Perceptions on Achievement

Many researchers working with attracting and holding power of exhibits have assumed that the primary reason for exhibit success or failure, in terms of visitor achievement, is a function of the nature of the stimulus. Salomon (1983), however, argues that the nature of the stimulus, the complexity, novelty, structuredness, pace, and other characteristics interacts with learners' abilities only to a certain extent when considering learning outcomes. A critical factor involved in determining learning outcomes is the amount of invested mental effort (AIME) that an individual consciously decides to devote to learning. The amount of mental effort an individual invests in learning is a decision made by the learner based on two basic perceptions: perceived demand characteristics of an information source and perceived self-efficacy. The perceived demand characteristics of an information source are based on (a) mental requirements of the media; (b) media attributes (depth, complexity, importance); (c) tasks to be performed; and (d) contexts in which one is exposed. When individuals perceive a source of information as serious and demanding, more effort is invested in learning. Perceived self-efficacy refers to the subjective judgments an individual makes concerning probability of success at a particular task. The more a learner believes in her/his ability to succeed at a task, the more likely the learner is to invest and sustain effort.

The cognitive outcome of sustained effort is deeper processing of information from a particular source. Deep processing involves mental elaborations of the material and increased contact with other pre-existing schema. An increased number of memory traces, more enriched meanings arrived at, increased long term memory storage, and recall and transfer to new material have all been related to deeper processing. If a task is perceived as easy, "mindful,"

active processing of information is bypassed and "mindless" processing occurs. Mindless processing results in poor performance on cognitive outcome measures (Salomon, 1983).

Salomon (1984) investigated the effects of learner perceptions and AIME on learning from two different instructional media: film and print. Subjects were instructed to either watch a film or read a text. Attention cues were not provided and the subjects were not made aware of an impending posttest. In this comparison film was perceived as realistic and easy, and learners reported high levels of self-efficacy. Print was perceived as demanding and requiring more effort. The outcome of the study was that self-efficacy was positively correlated with AIME for the print treatment group and negatively correlated with AIME for the film treatment group. There was no significant difference in ability to answer questions calling for recognition of events or actions that occurred in the film or text between treatment groups. Subjects who were exposed to printed material did show an increased ability to make inferences pertaining to the material read relative to subjects who viewed the film.

Nonetheless, learner perceptions of media are open to change. Kunkle, as cited in Salomon (1983) was able to vary learner perceptions of television and subsequent learning by telling subjects that the same television program was destined to be broadcast on either commercial or public TV. When told that the program being viewed was to be broadcast on public TV, more effort was invested and more learned, relative to the group who believed that the program was to be broadcast on commercial TV. Subjects in either treatment group were not provided with attention cues, were not made aware of the posttest, and were simply instructed to watch the program. The lack of an externally set task is important, because it could be hypothesized that the provision of an externally set task would affect the amount of invested mental effort. Salomon (1984)

noted that AIME is influenced by learner perceptions of the information source only "when relevant skills of effortful elaboration are available to learners, and in the absence of explicit, specific and unambiguous task requirements" (p. 649).

Research undertaken to investigate how perceptions of instructional media affect the amount of invested mental effort and learning has been limited to film, and television and print, except in one situation. Fire (1985), in an investigation of the effect of test cues, curiosity and AIME on learning from a museum exhibit, reported a significant and positive relationship between AIME and cognitive gain. However, the instrument which was used to measure AIME did not include any measure of perceived demand characteristics or perceived self-efficacy. The measurement was limited to a self-report of the amount effort the individual invested in the task. Also, the research protocol involved the use of exhibit mock-ups being brought to a classroom and was not actually carried out in an informal learning center.

An examination of visitor perceptions of informal learning centers would suggest that perceived demand characteristics of museums are quite low. Researchers investigating visitor goals for a visit to an informal setting noted that the primary reasons for a visit were for social and aesthetic purposes unrelated to the center's explicit educational goals (Cheek, 1976; Kellert, 1979; Kimche, 1978; Laetsch, Diamond, Gottfried, & Rosenfeld, 1980; Thier, 1984; White & Barry, 1984). When educational goals are reported in surveys of visitor perceptions and motivations, these goals are most often intended for another family member or group member and not for the individual surveyed.

In summary, the general absence of individually set goals of learning and the high frequency of goals dealing with social, aesthetic, and entertainment concerns would suggest that individual perceptions of informal learning centers may be a crucial factor in explaining the variation in learning. The amount that a

visitor learns from a visit to an informal learning center may be influenced by AIME to a much greater degree than issues concerning exhibit characteristics.

The Effect of Encoding Cues on Achievement.

Salomon (1983) postulated that AIME could be affected by the provision of explicit, specific, and unambiguous task requirements. An examination of the literature dealing with the encoding and processing of information would suggest that provision of specific instructions before being confronted with learning tasks in an informal learning center serves to change visitors' perceptions of perceived task demands. Providing a specific, unambiguous task that is perceived as difficult, may compensate for low perceived demand characteristics of a particular information source. Glover, Plake, and Zimmer (1982) point out that "difficult initial processing implies more extensive or elaborate analysis and that this more extensive analysis is reflected in a richer, more extensive memory record" (p. 191). This comment parallels Salomon's (1983) hypothesis that perceptions of an information source influence the amount of invested mental effort and that increasing effort leads to increased elaboration of the material. Salomon, however, was commenting on perceptions of an information source whereas Glover et al. were commenting on the perceptions of task difficulty.

Glover, Plake, and Zimmer (1982) systematically varied the difficulty of a task in order to study the relationship between task difficulty and recall. Subjects were presented with definitions of behavioral objectives as described by Bloom's taxonomy, then given 20 objectives and asked to identify each type. Following this activity, the subjects were asked to recall as many of the 20 items that they could. Task difficulty was not based on subjects' perceptions of the task, but inferred from the average probability of correctly identifying different objective types. Task difficulty was shown to increase as one moved from

identifying knowledge and comprehension objectives to identifying analysis and synthesis objectives. Glover et al. noted that objectives which were more difficult to identify were recalled at a higher rate. The finding that recall was positively related to increasing task difficulty is congruent with Salomon's (1984) finding that increasing perceptions of task difficulty is positively associated with learning outcomes.

Glover et al. (1982) clearly demonstrated the effect of task difficulty on encoding and recall of unrelated items for subjects in a single treatment group. The relationship between instructions, encoding and achievement has been carried out using radio, television, lecture, and text with a variety of instructional prompts used as encoding cues (Annis, 1985; Einstein, Morris, & Smith, 1985; Field & Anderson, 1985; Glover, Plake, Roberts, Zimmer, & Palmere, 1981; Peper & Mayer, 1986). Each of these research projects involved a single instructional media and two or more treatment groups. Treatments differed in the encoding cues subjects received. Each researcher assumed that the degree of difficulty or the degree of effort involved varied with the encoding cues provided. These researchers also noted that the instructions provided can have significant effects on what information is attended to and the degree to which the information is integrated.

Field and Anderson (1985) reported that the amount of effort invested in learning from television could be increased by providing instructions prior to viewing. Children who were prompted to "watch carefully" and were aware of an impending posttest performed significantly better on a posttest that examined cognitive gain, relative to children who watched the same program for entertainment. An interaction was noted between the instructions and the modality emphasized in the television program (audio versus visual versus audiovisual). Instructions elicited significant improvement for programs that

emphasized visual characteristics on both the cued recall and free recall posttests. Field and Anderson proposed an interaction between learning strategies and instructions. Here, children used audio cues as a means of selectively paying attention to visual material. When viewing television programs in which very little information was provided by the auditory modality and in the absence of instructions to "watch carefully", children paid little attention to the programs with visual emphasis and learned significantly less. Instructions to "watch carefully" appear to have selectively focused attention on visual aspects and subsequent learning from media that emphasized visual input. Provision of instruction also resulted in children reporting more effort invested in learning.

In an examination of the effect of note taking on learning from lecture, Einstein, Morris, and Smith (1985) compared cognitive gains of individuals instructed to take notes relative to individuals who were instructed to listen. Neither group was aware of an impending posttest that involved free recall of lecture material. Einstein et al. failed to discover any overall effect of treatment. When information recalled was scored according to the level of an item's importance in the text, a significant interaction was found. Note takers recalled significantly more propositions of high importance relative to subjects in the listen-only group.

Peper and Mayer (1986) reported similar findings when note takers were compared to listen-only subjects in their ability to answer questions regarding lecture material. When material was unfamiliar to the subjects, note takers performed significantly better than the listen-only group on problem solving questions. The note taking group performed marginally worse on questions calling for syntactic verbatim recognition, semantic verbatim recognition, and fact retention of unfamiliar material. When material was familiar, the note taking group and the listen-only group were not significantly different in their ability to

deal with questions calling for syntactic verbatim recognition, semantic verbatim recognition, fact retention, and problem solving. Peper and Mayer hypothesized that note taking served to relate presented information to existing knowledge and, thus, build a more integrated or broader learning outcome. They also hypothesized that, because of the reorganization of material resulting from note taking, performance on questions calling for syntactic verbatim recognition, semantic verbatim recognition, and fact retention was hindered when dealing with familiar material.

Although Einstein et al. (1985) and Peper and Mayer (1986) did not consider task difficulty within their research, the interpretations of their data are congruent with AIME theory. Both groups of researchers hypothesized that instructions given to subjects serve to increase the amount of effort invested by the learner. They also hypothesized that the increased effort results in increased elaboration and integration of new material with existing schema. Thus, it would appear that instructions serve to change subjects' perceptions of task difficulty when learning from oral discourse.

Researchers examining the effects of encoding instruction on learning from text have incorporated a broader range of instructions into their experimental protocol than were used in the previously discussed studies. Encoding instructions significantly affected subjects' ability to successfully answer questions that vary in the processing demands that are placed upon the learner. Instructions which call for information summary have been associated with a decreased ability to successfully answer questions that call for synthesis, analysis, and evaluation. For instance, Annis (1985) compared the effect of instructions on learning from text. Subjects were placed in one of three treatment groups which varied as a function of instructions received; take continuous notes, write paragraph summaries, or read only. Although the type

of information acquired by individual learners, under specific treatments, could vary without significantly changing overall learning, Annis's posttest included items that varied as described by Bloom's taxonomy. Annis found no significant differences between groups for knowledge or comprehension questions. For questions concerning analysis or application, the paragraph summary group scored significantly higher than either of the other groups. The reading only and continuous notes group scored significantly higher on synthesis and evaluation questions. Annis postulated that the difference between the note taking groups was due to a time restriction that limited the paragraph summary group. Thus, paragraph summary students benefited from paraphrasing textual material but did not have time to relate or associate new material with previously existing schema.

Glover, Plake, Roberts, Zimmer, and Palmere (1981) also examined the effects of note taking on encoding and learning from text. Glover et al. noted subjects would actively associate new and old material when prompted to do so while taking notes. The integration of material was demonstrated to occur to a greater degree for subjects prompted to do so relative to groups that were instructed to read a text or summarize paragraphs within the text. There was no significant difference between either notetaking group in the ability to recall information from the text. The notetaking groups did recall significantly more information than subjects who were instructed to read the text and not take notes.

In research involving learning from television, text and lecture, the provision of instructions had differential effects on learning outcomes. It is with this in mind that achievement was investigated in regard to subjects' ability to successfully answer recall and recognition questions and synthesis, analysis and application questions. It can be inferred from studies examining the effect of instructions on encoding and learning from text and oral communication that the

instructions can change subjects' perceptions of task difficulty and subsequently the amount of invested mental energy. No study to date has examined the effects of instructions, perceptions of the information source, amount of invested mental effort and learning simultaneously.

Ability Treatment Interactions and Learning in Informal Settings

General Ability

Visitors frequently enter an informal learning center with the goal of being entertained. Once inside the center, visitors are exposed to a series of exhibits. Educators and curators at informal learning centers have traditionally used objects and exhibits to communicate information. These objects are selected for their efficacy as examples of particular concepts and also for the interest that they will arouse. Individual goals, interests and general ability may interact, in ways that prevent realization of exhibit learning goals. This possibility is supported by researchers who have investigated the relationship between interest, attention and learning from text.

Shirey and Reynolds (1988) reported that in absence of specific learning instructions, or given instructions such as, "read the sentences so you will be able to recall them" (p. 165), low ability students either focus on information they find interesting or they set goals of reading for enjoyment. Within informal settings, attention to the interesting objects may take precedence over attention to learning objectives. Shirey and Reynolds also noted that poor readers tend to focus on information that is full of rich visual detail. This rich visual detail captures the readers interest based on internally set parameters. Fluent readers, however, define importance in terms of textual importance.

Given the rich, visual nature of an informal learning center and the quantity of objects and events chosen specifically for their interest, it could be predicted that a significant interaction would exist between instructional condition and general ability. Fire (1985) noted that low ability students benefited from encoding cues which guided them to salient features of the exhibit, whereas high ability students performed best in the absence of these cues. Researchers investigating learning from text and lecture have failed to show such a relationship under similar instructional condition. (Annis, 1985; Einstein, Morris, & Smith, 1985). The failure to note such interactions could be a function of the differences between the media. Subjects learning from text or lecture are not distracted by interesting objects or free to move on to other lectures or texts that may be of greater interest to them. College students have been shown to be able to successfully identify the level of importance of propositions within text and recall these propositions (Annis, 1985; Einstein et al. 1985). Thus, one might assume that college students could successfully identify the importance level of propositions within museum exhibits and recall these propositions. Consequently, low verbal fluency would not affect learning in an informal setting caused by an inability to identify important information.

Flexibility of Closure

Flexibility of closure is a cognitive factor defined as "the ability to hold a given visual percept or configuration in mind so as to disembed it from other well defined perceptual material" (Ekstrom, French, Harman, & Derman, 1976, p. 19). French et al. (1976) suggest that this construct be measured with the Hidden Figures Test. Flexibility of closure is related to the cognitive style of field independence. However, the two constructs are not identical. French et al. (1976) suggest using the Embedded Figures Test as a measure of field independence. Researchers investigating the effect

of subjects' spatial ability or disembedding ability have used both tests or tests strongly correlated to either the Hidden Figures Test or the Embedded Figures Test.

Flexibility of closure or disembedding ability has been incorporated into many research projects. However, how it is measured and whether or not it is viewed as a cognitive ability or a cognitive style has varied. Chandran, Treagust, and Tobin (1987) and Lord (1987) both used the Hidden Figures Test as suggested by French et al. but claims it is a measure of field independence. Other researchers have made use of the Find-A-Shape-Puzzle, which Staver and Jacks (1988) note loads on to the the same Factor as field independence measures, but refer to the test as a measure of spatial or disembedding ability (Carter, LaRussa, & Bodner, 1987; Pribyl & Bodner, 1987; Staver and Jacks, 1988).

Spiro and Tirre (1980), in an investigation of individual differences in schema utilization, found that score on the Group Embedded Figures Test interacted significantly with subjects' ability to superimpose a structure from memory on a stimulus structure. Individuals who scored high on the Group Embedded Figures Test were more able to "detect the relevance and applicability of pre-existing knowledge schema and superimpose those structures on the text in interaction with the text structure" (Spiro & Tirre, 1980, p. 207).

Staver and Jacks (1988), noted that increased disembedding ability, as measured by the Find-A-Shape Puzzle (an adaptation of Gottschaldt's Hidden Figures Test), was related positively with the ability to restructure information. They found that when considering the effects of prior knowledge, restructuring ability and working memory, only restructuring ability had any significant effect on students' performance of balancing chemical equations. The ability to restructure information allowed "learners to connect apparently unrelated facts, concepts and rules, and not overload working memory" (p. 774). This restructuring ability would seem to be of great

importance in learning from museum exhibits, where the relationship between exhibits is rarely explicitly stated.

Pribyl and Bodner (1987) in an examination of students' spatial ability and its role in organic chemistry noted that there was a relationship between this particular ability and students' success in answering questions that involved mentally manipulating two-dimensional representations of molecules. Pribyl and Bodner (1987) also used the Find-A-Shape-Puzzle test as a measure of spatial ability. They also found a positive relationship between spatial ability and the ability to answer questions that involved problem solving skills. No relationship was found between a subjects' spatial ability and the ability to answer questions that involved rote memory or simple algorithms. Pribyl and Bodner asserted that "high spatial students were better at disembedding relevant information from the statement of a problem, and transforming or restructuring the problem into one for which the student can recognize the initial and final or goal states" (p. 238). Thus, it would appear that an advantage is gained, not from the initial structuring and encoding of the information but the ability to understand questions that call for problem solving, such as synthesis, analysis, application, and evaluation questions.

Chandran, Treagust, and Tobin (1987) using the Hidden Figures Test, suggested that variation in scores on this test related to variation in ability to disembed relevant information from an irrelevant background. Witkin, Moore, Goodenough, and Cos (1977) found that the ability to disembed relevant information from an irrelevant background has contributed significantly to achievement in science.

Findings from studies by Staver and Jacks (1988), Spiro and Tirre (1980), Pribyl and Bodner (1987) and Witkin et al. (1977), would indicate that disembedding ability would likely be a strong predictor of an individual's ability to learn regardless of setting. As disembedding ability increased, the ability to superimpose knowledge structures on new information, to disembed relevant

information from an irrelevant background, to restructure new information into manageable "chunks," and successfully answer questions that called for problem solving with this information, also increases.

Flexibility of closure or disembedding ability as measured by the Hidden Figures Test may be of great importance for informal settings where learners encode information from text, objects, and pictures that are incorporated into an exhibit. Exhibits vary greatly in amount of verbiage and ratios of verbiage to objects, size and presentation style. In learning from a series of thematically linked exhibits, learners are required to recognize an overall objective, organize information from exhibits in terms of that objective and then superimpose that information on a the newly created mental structure. The ability to determine which characteristics of objects are relevant to the learning objectives of the exhibit and which are superficial would be especially important. Although objects within a case are displayed because they are outstanding examples of concepts addressed within an exhibit, they are also chosen for their aesthetic appeal, interesting qualities, and ability to attract visitors. However, these purposes may in fact be in conflict with one another. Superficial and irrelevant characteristics of the object may distract the visitor from discerning how the object exemplifies a particular concept. However, it could be predicted that as scores on the embedded figures test increase, the likelihood of being distracted by superficial characteristics of the object would decrease. Also, it could further be predicted that as disembedding ability decreases, learners may benefit from the more structured format of text.

Learner task preference

Characteristics that define an informal learning center - the relative lack of structure and the setting of learning goals by the individual - may have a profound effect on learning. Domino (1968) examined college students' academic success in classes that rewarded conforming behavior versus classes that rewarded independent behavior. He was seeking to examine the effect of motivational parameters that facilitate achievement. A bipolar construct was defined with individuals ranking themselves on a scale which ranged from extreme conformity to extreme independence. Individuals at the achievement via conformity end performed optimally in settings where conforming behavior, such as acceptance of regulations, a high degree of self-discipline, efficiency, and responsibility is rewarded. Individuals at the achievement via independence end performed optimally in situations which rewarded individuality, self-reliance, and creative innovation. Domino found strong relationships between measures on these scales, class type, and success in these college courses. Conforming classes were typified by clearly defined assignments, rare use of visual aids, and close conformity between lecture and text, among other variables. Courses rewarding independence were characterized by a variety of presentation types, assignments that called for divergent thinking and little overlap between text and class discussion.

The environment, described by Domino, that rewarded independent behavior includes many characteristics that are similar to the characteristics of informal learning settings described by Koran et al. (1983a). As preference to work on tasks that are internally set increases, one would predict increasing success in learning from informal learning settings in the absence of externally set task instructions. Conversely, as the preference to work on externally set

tasks increases, one would predict decreasing success in informal learning settings in the absence of specific task parameters.

Associative memory

The final construct that could be predicted to interact with the study treatments is associative memory. Masson and Miller (1983) found that scores on a reading span test related to an individual's ability to draw inferences from, integrate, and encode text information. But Masson and Miller noted that the normal adult reader does not depend simply on temporary storage of text information in working memory when considering successful reading comprehension. Koran and Koran, (1975) reported that when subjects are focused on relevant, question-related types of material in prose passages, there is a positive relationship between associative memory and retention of incidental information. Koran and Koran hypothesized that "the ability to form and remember new associations cannot be fully capitalized upon until the explicit nature of the associations to be formed and remembered are made clear" (p . 80). Lacking such instruction, high memory individuals were believed to try to remember too much or form irrelevant associations. Koran and Koran's findings would suggest that the provision of instructions that reinforce attention to relevant material would allow associative memory to be more effectively used in successfully answering recall and recognition questions.

Analysis of the effects of verbal fluency, associative memory, disembedding ability, and task preference would suggest that these abilities would interact with encoding instructions. Thus, this study incorporated the measurement of the above stated learner aptitudes into the research protocol.

Summary

The following are the major points derived from the literature reviewed in this chapter and which led to the hypotheses tested in this study:

1. Subject attention to exhibits is a critical step in learning from exhibits.
2. Exhibit characteristics can be modified to influence visitor attention.
3. It is difficult to infer that significant learning occurs as a function of exhibit characteristics and visitor attention.
4. Learning in informal settings occurs when visitor goals are congruent with exhibit goals.
5. Congruence between visitor goals and exhibit goals has occurred when the exhibit goals are explicitly stated, or when visitors are provided with cues that direct them to salient aspects of the exhibit.
6. The amount of effort invested in learning depends upon the perceived demand characteristics of the information source.
7. Effort invested in a task has been shown to vary systematically with the demands placed upon learners by task instructions.
8. Variation in task requirements can effect the degree to which information is encoded and new information is associated with previously acquired knowledge.
9. Learner abilities may interact with the encoding cues provided.

Hypotheses

Based on the aforementioned research, the following hypotheses were formulated:

1. There a positive relationship between museum demand characteristics (MDC) and effort invested in learning from museum exhibits and between MDC and

achievement, for all treatment groups, except for subjects who read a transcript of exhibit content.

2. There is a positive relationship between effort and achievement for all treatment groups.

3. There is a positive relationship between MDC and time spent on task for all treatment groups, except for subjects who read a transcript of exhibit content.

4. There is a positive relationship between time on task and achievement for all treatment groups.

5. Perceived task difficulty will vary as a function of treatment and there will be a positive relationship between perceived task difficulty and effort and perceived task difficulty and time on task for treatment groups viewing the exhibits.

6. There will be no significant difference between treatment group scores on the knowledge and comprehension portion of the achievement test.

7. Subjects who read a transcript of the exhibits' content will score significantly higher on a subtest composed of application, synthesis and analysis questions than subjects who view an exhibit or are instructed to write down one interesting thing from each exhibit or write down the main point.

8. Treatment will interact with subject aptitudes (verbal fluency, associative memory, embedded figures test score, and task preference), when examining achievement outcomes.

CHAPTER 3 MATERIALS AND METHODS

Subjects and Treatment Groups

The subjects in this study were college undergraduates enrolled in education courses at the University of Florida. A total of 169 students volunteered to participate. Of the 169 students, 137 of them were female and 32 were male. They were randomly assigned into one of four treatment groups. Treatment groups were established by the instructions given to subjects. Subjects in the "look" treatment group were simply asked to view the exhibits in the order that they were sequenced. Subjects in the "interest" treatment group were instructed to view the exhibits and write down one thing that they found interesting about each exhibit. Subjects in the "main point" treatment group were asked to view the exhibits and write down the main point(s) of each exhibit. Subjects in the "text" treatment group were asked to read a transcript of the museum exhibits. The transcript was a word for word copy of the written information found in the 11 exhibits that the subjects in the look, interest, and main point treatment groups encountered. Subjects in the text treatment group did not view the exhibits. Subjects in every treatment group were informed that they could devote as much time as they chose to the task and were instructed not to return to any exhibit once they finished or review any material in the text created from the exhibit. There were 47 subjects in the look treatment group, 44 subjects in the interest treatment group, 39 subjects in the main point treatment group, and 37 subjects in the text treatment group.

Materials

This study was carried out at the Florida Museum of Natural History. A series of 11 museum exhibits housed in the Discovery Room were used in the study. These exhibits are standard case exhibits, each containing objects, pictures, diagrams, and verbal content. All exhibits pertained to Florida natural history.

Titles of the exhibits are Mammal Invasions and Introductions in Florida, Genetic Variation in Mammals, Florida: Land or Sea? Tropical Ice Age Mammals, The Formation of Fossils, Invertebrate Fossils and Their Living Counterparts, Freshwater Clams and Snails of the Gulf Coast Region, Important Clues to Bird Identification, Identifying Birds by Their Behavior and Their Places in Environments, Poisonous Snakes of Florida, and Interesting Amphibians and Reptiles of Florida. The previously stated titles are given in the order that the exhibits are sequenced in the Museum. The written material in each exhibit was transcribed and used to create a text which covered the same material as the 11 exhibits (Appendix A).

Measures

Prior to carrying out the treatments, subjects were tested to obtain a measure of their perceptions of museums as learning environments. This score will be referred to as perceived museum demand characteristics (MDC). Following the treatment, subjects reported the perceived difficulty of the treatment, the amount of effort invested in the treatment, task preference, perceptions of museums as learning environments, and they also took an achievement test. Tests of verbal fluency, associative memory, and the hidden figures test were administered at the subjects' convenience as these aptitudes were not expected to change as a result of experimental treatments. All subjects were given the aptitude tests within a two week period before or after treatment. Definitions of learner aptitudes and other terms critical to the work are found in the Glossary.

Measures of verbal fluency, associative memory and flexibility of closure were taken from the Kit of Reference Tests for Cognitive Factors (French, Ekstrom, Harman & Derman, 1976). Verbal fluency was measured using the Extended Range Vocabulary Test (V-3). Associative Memory was measured using the First and Last Names Test (MA-3). Disembedding ability was measured with the Hidden Figures Test (CF-1, revised). French, Ekstrom, Harmon, and Derman (1976) report that reliability of these factor tests has consistently been found to exceed 0.70. The reliabilities reported by French et al. were summarized from a wide variety of studies.

In order to measure of subjects' perceptions of museum demand characteristics (MDC) was constructed which was composed of a five item Likert scale test (Appendix B). Items on the test were generated to examine; subjects' motivation to visit a museum, subjects' perceptions of the difficulty of learning from museums, and subjects' perceived self-efficacy in regard to learning from museums. Items on the test were generated in light research which examined the relationship between visitor perceptions and achievement (Salomon, 1983, 1984). Reliability of the instrument was determined via a split-half method. The 10-item test was given to 230 college undergraduates. The reliability of the museum demand characteristics measure, based on the Spearman Brown prophecy was .76

One other Likert scale item was administered along with the MDC instrument. Subjects were asked to rate how much fun they believed museums to be, relative to reading a text, on a one to five scale. A semantic differential item was administered where subjects rated their preferences to working on tasks that they set for themselves versus tasks set for them (Appendix B).

A 37-item achievement test was given to all subjects following completion of assigned treatment (Appendix C). All items were generated from a pool of questions composed by four graduate students in the Zoology Department and the College of Education. Two other graduate students determined the content validity of the 37 item

test. Twenty- nine of the items within the test were questions at the knowledge and comprehension levels of learning. Discriminative validity of the recognition and comprehension questions had been determined in a pilot study that compared achievement of subjects who had viewed the 11 exhibits with individuals who did not view the exhibits. Individuals who viewed the exhibits scored significantly higher than individuals who did not view the exhibits. The remaining eight questions called for synthesis and application of the information presented in the museum exhibits. Correct answers for all questions were determined and all tests were scored based on these answers. No partial credit was given. Reliabilities of the achievement tests were carried out using Cronbach's alpha. A summary of the reliability measures for the Museum Demand Characteristics Test and the Knowledge Posttests is provided in Table (3-1).

General Procedure

Subjects were recruited from students enrolled in courses in the College of Education, Spring semester 1989. Prior to recruitment, all individuals in a given class filled out the split-half test form addressing perceptions of museums. Individuals were then asked to participate in a study of exhibit design, and subjects signed up on a volunteer basis. Subjects were not aware of which exhibits had been incorporated into the study, experimental treatments, or the fact that they would be tested on exhibit content following completion of the treatment.

Upon arrival at the museum, subjects were escorted to the exhibits and given verbal instructions which varied dependent upon treatment. The researcher or assistant then moved away from the exhibits to a desk, yet kept the subject in viewing distance with the subject's back to the researcher. A stopwatch was used to determine the amount of time each subject spent in front of the exhibits.

Upon completion of the task, each subject was given a test of museum demand characteristics, asked to rate the perceived difficulty of the assigned task and the amount of effort they put into the assigned task, and given the test covering the exhibit content. Tests of verbal fluency, associative memory and the hidden figures test were given at the subjects' convenience as these aptitudes were not expected to change as a result of experimental treatments.

Statistical Analyses

All analyses of main effects, treatment effects and aptitude treatment interactions were carried out using multiple regression analysis. When examining treatment effects and interactions between aptitudes and treatments, slopes describing the relationship between predictor variables and outcome variables were compared. The effect of the treatment on subjects' perceptions of museums as fun was analyzed with Student's t-tests. All analyses were tested at the .05 level.

Table 3-1
Reliability of Museum Demand Characteristics Test and Achievement Tests

Test	Method	Reliability
Museum Demand Characteristics	Spearman Brown Prophecy	.76
Total Test	Coefficient Alpha	.80
High Level Subtest	Coefficient Alpha	.55
Low Level Subtest	Coefficient Alpha	.79

CHAPTER 4 RESULTS

Research Questions

It will be remembered that the hypotheses to be tested in this study were:

1. There a positive relationship between museum demand characteristics (MDC) and effort invested in learning from museum exhibits and between MDC and achievement, for all treatment groups, except for subjects who read a transcript of exhibit content.
2. There is a positive relationship between effort and achievement for all treatment groups.
3. There is a positive relationship between MDC and time spent on task for all treatment groups, except for subjects who read a transcript of exhibit content.
4. There is a positive relationship between time on task and achievement for all treatment groups.
5. Perceived task difficulty will vary as a function of treatment and there will be a positive relationship between perceived task difficulty and effort and perceived task difficulty and time on task.
6. There will be no significant difference between treatment group scores on the knowledge and comprehension portion of the achievement test.
7. Subjects who read a transcript of the exhibits' content will score significantly higher on a subtest composed of application, synthesis and analysis questions than subjects who view an exhibit or are instructed to write down one interesting thing from each exhibit or write down the main point.

8. Treatment will interact with subject aptitudes (verbal fluency, associative memory, hidden figures test score, and task preference), when examining achievement outcomes.

Variables

Data were collected for all subjects on measures of museum demand characteristics (MDC), verbal fluency, associative memory, hidden figures test (HFT), and task preference. Descriptive statistics for these variables are reported in Table 4-1. Correlations between scores on the verbal fluency, associative memory and hidden figures test are reported in Table 4-2.

Scores were obtained for all subjects on an achievement posttest composed of 38 questions (total test score). As encoding instructions have been demonstrated to significantly affect subjects' ability to answer questions with different processing demands, the scores were subsequently divided into one score for 29 recall and recognition items (low level subtest) and another score for 8 synthesis, application and analysis items (high level subtest). Additionally, the length of time that students spent in the vicinity of each exhibit was recorded, and subject self-reports of invested effort, perceived difficulty of task, and posttreatment museum demand characteristics were measured before the criterion test was taken. The within treatment group means and standard deviations for these variables are reported in Table 4-3.

Descriptive statistics for subjects' perceptions of museums as fun are reported in Table 4-4. When examined for within group changes, only the look treatment group showed any significant change. Subjects in the look treatment group showed an increase in the degree to which museums were perceived as fun ($p < .05$, T-test).

General and multiple linear regressions were used to examine relationships between all outcome variables and aptitudes. Predictor variables incorporated into the analyses included; scores on all aptitude tests, museum demand characteristics (MDC),

time spent on task, subject report of effort expended on task, and task preference. Outcome variables included time on task, posttreatment museum demand characteristics, effort expended, perceived difficulty of task assigned, total score on achievement test, and score on low level and high level subtests. R-squared values for all analyses are found in Appendix D.

Table 4-1
Aptitude Data

Aptitude	Treatment							
	<u>Look</u>		<u>Interest</u>		<u>Main point</u>		<u>Text</u>	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
MDC	12.5	3.6 n = 42	11.8	2.8 n = 43	12.2	3.3 n = 36	12.5	3.6 n = 33
Task Preference	9.2	3.3 n = 46	9.6	3.2 n = 45	9.8	4.0 n = 38	8.8	3.5 n = 36
Hidden Figures Test	11.1	6.9 n = 45	12.8	6.9 n = 45	14.1	6.2 n = 38	13.4	7.2 n = 35
Verbal Fluency	22.4	6.5 n = 46	23.8	6.7 n = 45	24.9	8.3 n = 38	25.8	8.2 n = 35
Associative Memory	19.6	6.9 n = 45	20.4	6.9 n = 45	18.4	7.0 n = 38	19.7	6.5 n = 35

Table 4-2

Correlations between Hidden Figures Test (HFT), Associative Memory, Verbal Fluency, and Total Test Score

Test	Hidden Figures Test	Associative Memory	Verbal Fluency	Total Test Score
HFT (p)	1.00 0.00	-0.02 0.77	0.26 0.0005	0.41 0.0001
Associative Memory (p)		1.00 0.00	0.26 0.001	0.14 0.07
Verbal Fluency (p)			1.00 0.00	0.45 0.001
Total Test Score (p)				1.00 0.00

Table 4-3
Outcome Data

Variable	Treatment							
	<u>Look</u>		<u>Interest</u>		<u>Main point</u>		<u>Text</u>	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Time	22.9	9.6 n = 46	37.7	12.5 n = 45	53.0	15.6 n = 38	25.5	6.2 n = 36
Total Test Score	25.5	8.4 n = 47	26.1	9.9 n = 45	27.8	8.7 n = 39	25.3	9.0 n = 36
High Level Subtest	10.3	4.4 n = 47	10.6	4.3 n = 45	9.5	4.2 n = 39	9.5	4.0 n = 36
Low Level Subtest Score	15.3	5.6 n = 47	15.8	5.8 n = 45	18.0	5.9 n = 39	15.8	6.1 n = 36
Task Difficulty	2.5	0.9 n = 47	2.5	0.9 n = 45	2.7	0.9 n = 39	2.7	0.9 n = 36
Effort	2.9	0.9 n = 47	3.0	0.9 n = 45	3.1	1.0 n = 39	3.3	1.0 n = 36
Posttreatment MDC	14.0	4.0 n = 46	13.2	3.5 n = 44	13.4	4.4 n = 39	13.0	3.2 n = 36

Table 4-4
Means and Standard Deviations for Subject Self Report of Museums as Fun

Treatment	Before Treatment Score		After Treatment Score	
	Mean	SD	Mean	SD
Look	1.5 n = 41	0.7	1.8 n = 46	1.0
Interest	1.5 n = 42	0.6	1.7 n = 44	0.7
Main point	1.5 n = 36	0.6	1.7 n = 37	0.7
Text	1.7 n = 32	0.8	1.7 n = 35	0.7

Subject Report of Effort Expended on Task

The following hypotheses were of major concern regarding subjects' perceived museum demand characteristics and amount of invested mental effort :

1. There will be a positive relationship between museum demand characteristics and effort for all treatment groups that view the exhibits.
2. There will be no relationship between museum demand characteristics and effort for the text treatment group.

All subjects' perceived museum demand characteristics (MDC) were measured using a five item, Likert scale instrument. Score increases on the instrument were related to increasing perceptions of museums as demanding. Effort was rated on a 1 to 5 scale. A report of 1 was related to little investment of effort and 5 was related to a great deal of effort invested.

There was a significant negative relationship between museum demand characteristics and effort expended on task, $F(7,141)=3.45$, $p < .005$. As noted in Table G-1, there were two significant interactions, MDC X text ($t = 2.375$, $p < .0189$)

and MDC X interest, ($t = 1.997$, $p < .0477$). The interaction between treatment and museum demand characteristics in regard to invested effort is represented in Figure 4-1.

The relationship between museum demand characteristics and invested effort was negative for all treatment groups. However, the relationship between museum demand characteristics and invested effort approached zero for the text and interest treatment groups. There was a significant difference between the look treatment group and the text and interest groups ($p > .05$). As subjects' in the look and main point treatments perceptions of museums as difficult increased, they invested decreasing amounts of effort. There was no significant difference between the look and main point treatment groups ($p > .05$). There was no significant difference between the text and interest treatment groups. ($p > .05$). Nor was there any significant difference between the main point, interest and text treatment groups ($p > .05$). Slopes and intercepts for the interaction between museum demand characteristics and invested effort appear in Table 4-5

Table 4-5
Descriptive Statistics for Museum Demand Characteristics X Treatment Interactions for Subject Self Report of Invested Effort

Treatment	Intercept	Slope
Look	4.67	-.14
Interest	3.12	-.01
Main point	4.30	-.10
Text	3.43	-.004

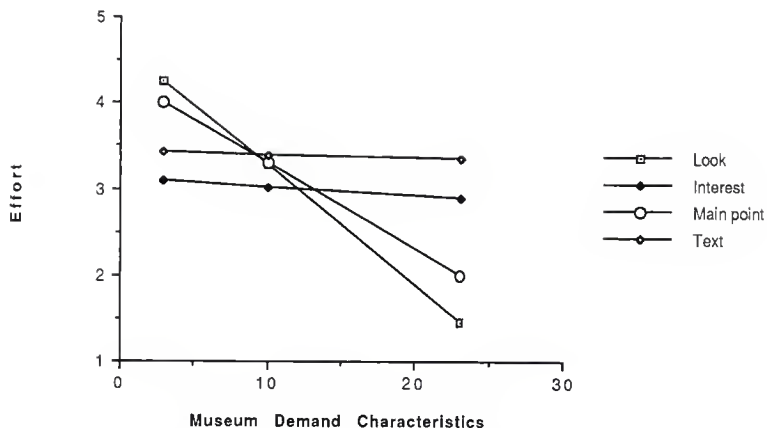


Figure 4-1. The interaction between museum demand characteristics and treatment on subject report of effort expended on task.

Time on Task

The following hypotheses were of major concern regarding time on task:

1. There will be a positive relationship between museum demand characteristics and time on task for all treatment groups that view the exhibits.
2. There will be no relationship between museum demand characteristics and time on task for the text treatment group.

Mean times spent on task for look, interest, main point, and text treatment groups were 22.9, 37.7, 53.0, and 25.5 minutes, respectively. Subjects in the interest and main point groups spent significantly more time on task than did subjects in the look group ($t = 11.057$, $p < .0001$) and ($t = 5.407$, $p < .0001$). There was no

significant difference in the mean amount of time spent on task between look and text treatment groups ($t = 0.930, p > .3537$). The mean amount of time spent on task by subjects in the main point treatment group was significantly greater than all the mean time spent on task by all other treatment groups ($p < .0001$). Summary statistics are found in Table F-1.

A significant interaction between subject report of effort invested and treatment as it related to time on task was noted for the main point treatment group ($t = 2.090, p < .0382$). The interaction is represented in Figure 4-2. Summary statistics are found in Table G-2. There was no significant relationship between effort invested and time spent on task for look, text, and interest treatment groups. Slopes and intercepts describing the relationship between effort invested and time spent on task are presented in Table 4-6.

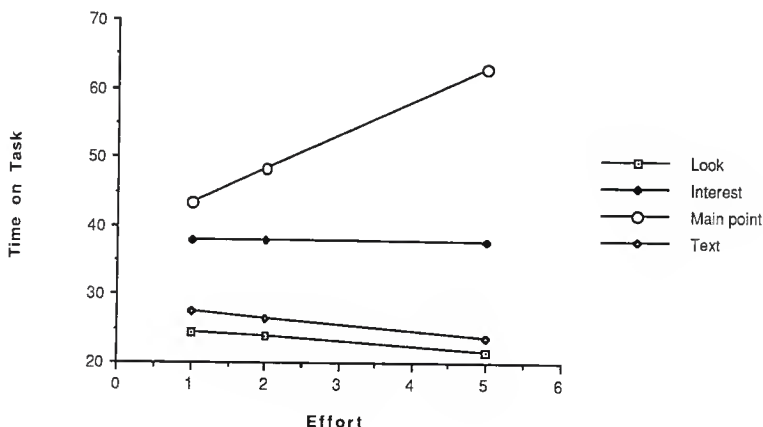


Figure 4-2. The interaction between effort and treatment on time spent on task.

Table 4-6
Descriptive Statistics for Effort X Treatment Interactions for Time Spent on Task

Treatment	Intercept	Slope
Look	25.2	-.71
Interest	26.6	-.10
Main point	38.6	4.83
Text	28.5	-.93

Subject Report of Task Difficulty

The following hypotheses were of importance in regard to subjects' perceptions of task difficulty:

1. There will be no significant difference between perceived task difficulty as a function of treatment.
2. Subjects who perceive their task as difficult will invest more mental effort, and spend more time on task.

All subjects were asked to rate the difficulty of their assigned task on a 1 to 5 scale where 1 was very difficult and 5 was very easy. There were no significant treatment effects ($p > .05$). Controlling for the effect of any aptitude variable still did not result in any significant treatment effect ($p > .05$).

There was a significant positive relationship between perceived museum demand characteristics and perceptions of task difficulty, $F(1, 146) = 6.27, p < .01$. Slopes and intercepts are found in Table 4-7. Summary statistics are presented in Tables E-1.

Time on task was positively related to subjects' reports of task difficulty for the look treatment group ($t = 2.08, p < .0388$). Significant interactions were noted between

time spent on task and treatment when examining subject reports of task difficulty for the main point and interest treatment groups ($t = -3.05$, $p < .0027$ and $t = -2.24$, $p < .0364$, respectively). The relationship between time on task and subject report of task difficulty is represented in Figure 4-3. Summary statistics are presented in Table G-3.

The relationship between time on task and subject report of task difficulty was significant for all treatment groups ($p < .05$). However, the direction of the relationship varied with treatment. There was a positive relationship between time on task and perceived task difficulty for the look and text treatment groups. There was no significant difference between these two treatments ($t = 0.04$, $p > .05$). There was a negative relationship between time on task and perceived task difficulty for the interest and main point treatment groups. There was no significant difference between these two treatments ($t = 0.6776$, $p > .05$). Slopes and intercepts for the interaction between time on task and perceived task difficulty are presented in Table 4-8.

Table 4-7
Summary of Main Effects

Outcome Variable	Predictor Variable	Intercept	Slope
Task Difficulty	MDC	1.9	.06
Total Test Score	Verbal Fluency	14.1	.52
Total Test Score	Associative Memory	21.7	.25
Total Test Score	Hidden Figures Test	21.4	.41
Total Test Score	Time on Task	21.8	.13
High Level Subtest	Hidden Figures Test	11.4	3.1
High Level Subtest	Verbal Fluency	6.2	2.8
High Level Subtest	Task Preference	12.1	-.19
Low Level Subtest	Time	12.0	4.5

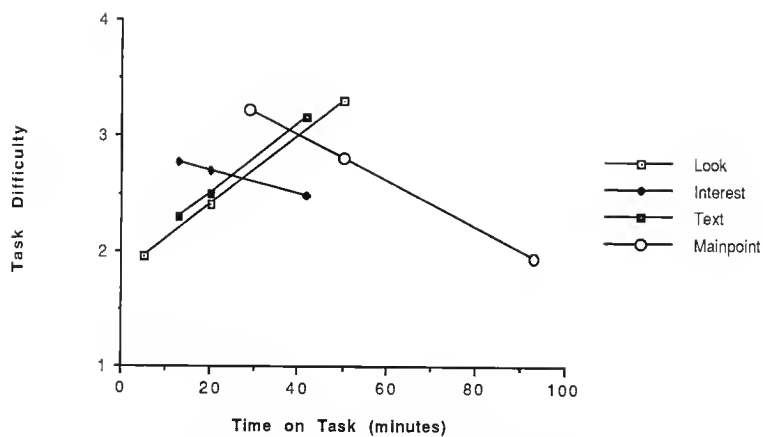


Figure 4-3. Interaction between time on task and treatment on perceived task difficulty.

Table 4-8
Descriptive Statistics for Time on Task X Treatment Interactions Regarding Perceived Task Difficulty

Treatment	Intercept	Slope
Look	1.8	.03
Interest	2.9	-.01
Main point	3.8	-.02
Text	1.9	.03

Posttreatment Museum Demand Characteristics

There was a significant negative relationship between subject report of effort expended on task and posttreatment museum demand characteristics for the look treatment group ($t = -3.683, p < .0003$). There was no significant difference in slopes describing the relationship between effort expended on task and posttreatment museum demand characteristics for the look and main point treatment groups ($t = 0.980, p > .3287$). Two significant interactions were noted Effort X text and Effort X interest ($t = 2.557, p < .0115$ and $t = 2.549, p < .0118$, respectively). The interaction between effort and treatment on posttreatment museum demand characteristics is represented in Figure 4-4. Summary statistics are presented in Table G-4. For both the text and interest treatment groups, there was a significant positive relationship between effort and posttreatment museum demand characteristics for the interest and text treatment groups. These two treatments were not significantly different from each other ($t = .0004, p > .05$). As subjects in the interest and text treatment groups invested more effort, their perceptions of museums as difficult decreased. Slopes and intercepts for the interaction between effort invested and treatment as it relates to posttreatment museum demand characteristics are reported in Table 4-9.

The relationship between museum demand characteristics and posttreatment museum demand characteristics was positive for all treatment groups, $F(7, 139) = 11.4$, $p < .05$. However, a significant interaction was noted between the text treatment group and pretreatment museum demand characteristics ($t = -1.93$, $p < .0552$). This interaction is represented in Figure 4-5. Summary statistics are reported in Table G-5. None of the slopes describing the relationship between pre- and posttreatment museum demand characteristics were greater than one. Thus, for all treatment groups there was a decrease in perceived difficulty of museums after treatment. The slope which describes the relationship between pre- and posttreatment museum demand characteristics for the text treatment was significantly less than the slope for all other treatments ($p < .05$). There was, however, no significant difference between slopes of the lines that describe the relationship between pre- and posttreatment museum demand characteristics for any of the other three treatment groups ($p > .05$). Summary statistics are reported in Table 4-9.

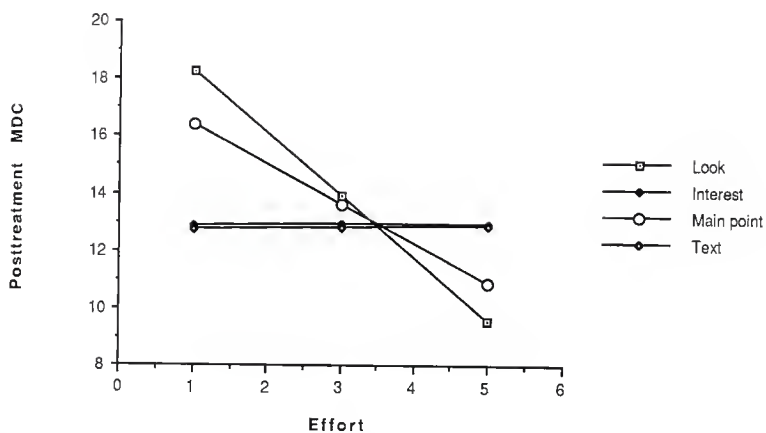


Figure 4-4. The interaction between effort and treatment on posttreatment museum demand characteristics (MDC).

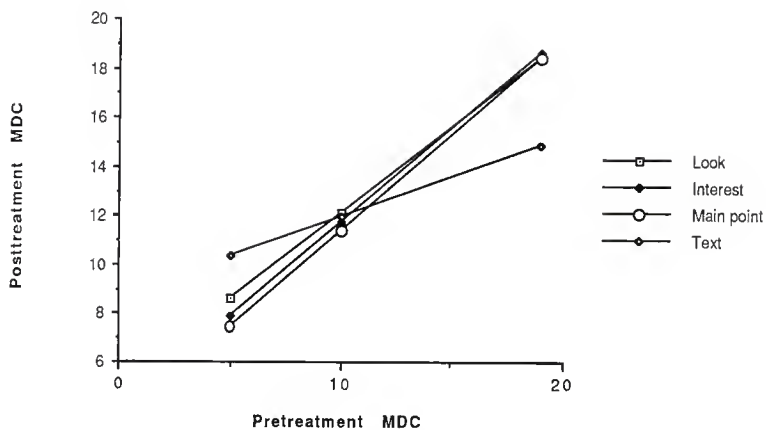


Figure 4-5. The interaction between pretreatment museum demand characteristics (MDC) and treatment on posttreatment museum demand characteristics (MDC).

Table 4-9
Descriptive Statistics for Aptitude X Treatment Interactions regarding Posttreatment Museum Demand Characteristics

Treatment	Intercept	Slope
<u>Interacting Variable = Subject Self Report of Effort</u>		
Look	20.42	-2.2
Interest	12.83	.02
Main point	17.76	-1.4
Text	12.66	.04
<u>Interacting Variable = Pretreatment Museum Demand Characteristic</u>		
Look	5.11	.70
Interest	3.58	.78
Main point	4.03	.77
Text	8.77	.32

Total Test Score

The following hypotheses were of importance regarding the total test score:

1. There is a positive relationship between museum demand characteristics and total test score, except for the text treatment group..
2. There will be a positive relationship between effort and total test score.
3. There is a positive relationship between time on task and total test score for all treatment groups.
4. There will be an interaction between treatment and scores on the associative memory test, hidden figures test score, verbal fluency, and task preference regarding high level subtest.

There was no main effect of museum demand characteristics or effort regarding total test score ($p > .05$). There was no significant interaction between museum demand characteristics and total test score ($p > .05$). The score on the new total test was significantly and positively related to the subjects scores on the tests of verbal fluency, $F(1, 147) = 2.251, p < .0005$, associative memory, $F(1, 147) = 2.251, p < .05$, hidden figures test score, $F(1, 147) = 2.251, p < .0005$, and time on task, $F(1, 147) = 2.251, p < .005$. Slopes and intercepts are presented in Table 4-7. Summary statistics are presented in Tables E-2, E-3, E-4, and E-5. There were no significant effects of treatment, no significant effect of treatment when controlling for aptitude variables and no significant aptitude treatment interactions ($p > .05$). When the effects of verbal fluency, hidden figures test score, and associative memory were controlled for simultaneously; only verbal fluency and hidden figures test score accounted for a significant portion of the total variance in total test score ($p < .05$). Summary statistics for this model are presented in Table E-6.

Scores on the High Level Subtest

The reader will recall that the high level subtest was composed of nine questions calling for synthesis, analysis and application of information. The following hypotheses were of importance in regard to the high level processing subtest:

1. There will be positive relationship between museum demand characteristics and high level subtest score for all treatment groups except the text treatment group.
2. Subjects in the text treatment will score significantly higher than all other treatment groups on the high level subtest.
3. There is a positive relationship between time on task and high level subtest score for all treatment groups.

4 There will be an interaction between treatment and scores on the associative memory test, hidden figures test score, verbal fluency, and task preference regarding high level subtest.

There was a significant positive relationship between high level subtest and scores on the test of hidden figures, $F(1, 147) = 10.20, p < .005$. There was also a significant positive relationship between verbal fluency and high level subtest score, $F(1, 146) = 7.854, p < .0058$. There was a significant negative relationship between high level subtest and task preference, $F(1, 147) = 10.20, p < .005$. Slopes and intercepts are presented in Table 4-7. Summary statistics are presented in Tables E-7, E-8, and E-9. When the effects of verbal fluency, hidden figures test score, and associative memory were controlled for simultaneously; only hidden figures test score accounted for a significant portion of the total variance in total test score ($p < .05$). Summary statistics for this model are presented in Table E-10.

Scores on the Low Level Subtest

The reader will recall that the low level subtest was composed of 29 items calling for the recall and recognition of exhibit content. The following hypotheses were of importance in the consideration of scores on the low level processing subtest:

1. There will be positive relationship between museum demand characteristics and low level subtest score for all treatment groups except the text treatment group.
2. There is a positive relationship between effort and low level subtest score for all treatment groups.
3. There is a positive relationship between time on task and low level subtest score for all treatment groups.
4. There will be no significant difference between treatment group scores on the low level subtest.

5. There will be an interaction between treatment and scores on the associative memory test, task preference, hidden figures test score, and verbal fluency in predicting low level subtest score.

There was a significant positive relationship between time on task and score on the low level subtest $F(1, 164) = 20.0181, p < .0001$. Summary statistics are found in Table E-11.

There was a significant treatment effect for low level subtest score, $F(3, 145) = 2.682, p < .05$. Mean low level subtest scores for the look, main point, interest and text treatment groups were 15.23, 18.71, 15.93, 15.93, respectively. Subjects who were in the main point treatment group scored significantly higher than all other groups ($t = .0107, p < .05$). There was no significant difference between the scores of subjects in the look, interest and text treatment groups ($p > .05$). Summary statistics are reported in Table F-2.

There were significant positive relationships between low level subtest score and verbal fluency, $F(4, 144) = 13.405, p < .0001$, and associative memory, $F(4, 144) = 3.494, p < .01$, and hidden figures test score, $F(4, 144) = 3.530, p < .01$. The relationships between low level subtest score and verbal fluency, associative memory, and hidden figures test score were all positive. When controlling for verbal fluency, associative memory, or hidden figures test score subjects in the main point treatment group scored significantly higher than all other treatment groups, with no significant difference noted between the text, look, and interest treatment groups. The relationship between treatment and low level subtest scores controlling for verbal fluency is represented in Figure 4-6. Slopes and intercepts for treatment effects controlling for verbal fluency, associative memory, and test of hidden figures are presented in Table 4-10. Summary statistics are presented in Tables F-3, F-4, and F-5.

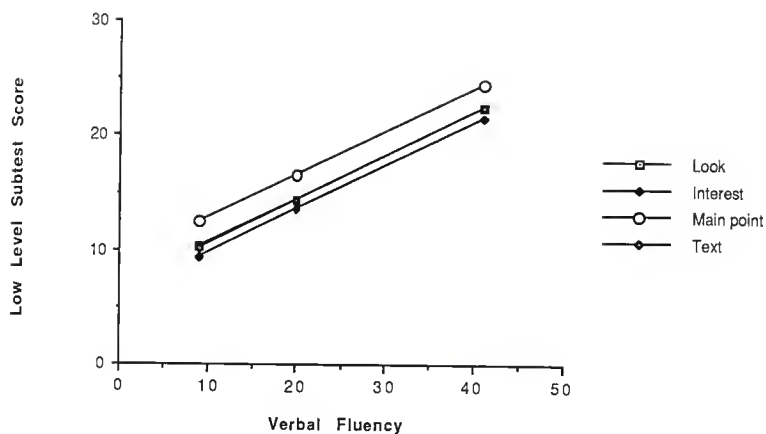


Figure 4-6 The effect of treatment on low level subtest after controlling for verbal fluency.

Table 4-10
Descriptive Statistics for Treatment Effects regarding Low Level Subtest Score

Treatment	Intercept	Slope
<u>Controlled Variable = Verbal Fluency</u>		
Look	6.8	.38
Interest	6.8	.38
Main point	8.9	.38
Text	6.0	.38
<u>Controlled Variable = Associative Memory</u>		
Look	11.0	.17
Interest	11.4	.17
Main point	14.6	.17
Text	11.6	.17
<u>Controlled Variable = Score on the Hidden Figures Test</u>		
Look	13.3	.18
Interest	13.6	.18
Main point	15.9	.18
Text	13.4	.18

There was a significant negative relationship subject task preference and scores on the low level subtest of the achievement test for the main point treatment group ($t = -2.265$, $p < .0249$). As subjects' preference to work on tasks set by themselves increased, scores on the low level subtest decreased. There was no significant relationship between task preference and score on the low level subtest score for any other treatment group. The interaction between task preference and treatment in regard

to low level subtest score is represented in Figure 4-7. Summary statistics are reported in Table G-6. Slopes and intercepts for the interaction between task preference and treatment as it relates to low level subtest score are reported in Table 4-11.

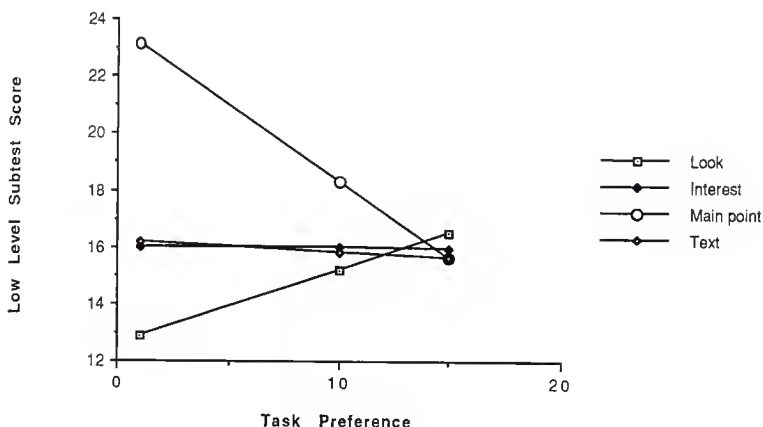


Figure 4-7. The interaction between task preference and treatment on low level subtest

Table 4-11
Descriptive Statistics for Aptitude X Treatment Interactions for Low Level Subtest Test Score

Treatment	Intercept	Slope
<u>Interacting Variable = Task Preference</u>		
Look	12.6	.26
Interest	16.0	-.005
Main point	23.7	-.54
Text	16.2	-.04

Summary of Results

In conclusion, the data can be summarized by the following:

1. There was a significant negative relationship between subjects' perceived demand characteristics of museums and effort for the main point and look treatment groups. There was no relationship between subjects' perceived demand characteristics of museums and effort for the text and interest treatment groups.
2. There was no relationship between effort invested in learning and time on task for any treatment group except the main point treatment group. There was a positive relationship between effort invested and time on task for the main point treatment group
3. As subjects in the main point and interest treatment group spent increasing amounts of time on task, subject report of task difficulty decreased. As subjects in the text and look treatment groups spent more time on task, subject report of task difficulty increased.
4. As subjects spent more time on task, posttreatment reports of perceived museum demand characteristics decreased.
5. As subjects in the look and main point treatment group invested more effort in learning, their posttreatment perceived museum demand characteristics decreased.
6. Subjects in the main point treatment group scored significantly higher on the low level subtest relative to any treatment group.
7. Total test score was positively related to verbal fluency, associative memory, hidden figures test score, and time on task for all treatment groups.
8. A multiple regression model that controlled for verbal fluency score on the hidden figures test, and associative memory indicated that associative memory did not account for a significant amount of the variance in total test score, and high level subtest scores.

9. There was no significant difference between treatment group scores on the high level subtest.

10. High level subtest was significantly related to scores on the hidden figures test and verbal fluency, and negatively related to task preference.

11. Low level subtest score was positively related to verbal fluency, score on the hidden figures test, associative memory, and time on task.

12. As subjects in the main point treatment group increasingly preferred to work on tasks that they set for themselves, their score on the low level subtest decreased. There was no relationship between task preference and low level subtest score for the look, interest, and text treatment groups.

CHAPTER 5 DISCUSSION AND CONCLUSION

Perceived Museum Demand Characteristics, Effort and Time on Task

This research project was carried out, in part, to examine the relationship between how difficult individuals perceive learning from museum exhibits to be and the amount of effort invested in learning and to investigate how this interrelationship affects achievement. Salomon (1983) hypothesized that as the perceived demand characteristics of an information source increased, the learner would invest more mental effort and subsequently learn more. The work upon which Salomon supports his theory has been limited to settings in which the learner has no choice of stimuli or amount of time to spend on a task. In such a highly controlled setting, learner perceptions of the media may explain the variance in achievement better than cognitive variables and variables which describe the nature of the stimuli. However, based on results from this study, it could be suggested that with decreasing amounts of structure, the role of learner perceptions may decrease in importance. Success or failure, when examining learning in informal settings seems to be more a function of learner cognitive abilities, task preference, and the nature of the tasks to be performed than learner perceptions regarding the media.

A positive relationship between perceived difficulty and effort expended in learning is a crucial point in Salomon's exploration of differential investment of mental effort in learning from different instructional sources. Contrary to what would be predicted based on Salomon's (1983) theory, in this study, relationships between perceived demand characteristics and effort invested in learning were functionally

nonexistent or negative. Individuals in the look and main point treatment groups invested a greater amount of effort when museums were perceived as easy. There was no relationship between perceived museum demand characteristics and effort for individuals in the interest and text treatment groups.

Informal learning centers are characterized as being free choice environments. Visitors at these centers are not required to closely examine each exhibit. Instead, visitors choose which exhibits they wish to attend to and the amount of effort they wish to invest. The relationship between perceived museum demand characteristics and effort, reported in this study, may be a function of motivating factors which lead visitors to attend to and learn from specific exhibits. Researchers exploring learning in informal settings have noted that one key distinction between learning in formal and informal settings is that individuals are internally motivated to learn in an informal setting. In contrast, subjects involved in research carried out to investigate the relationship between learner perceptions, AIME and learning, may have been provided with some external motivation to learn.

In an informal setting, an internally motivated individual may actively choose not to attend to an exhibit. This decision may not necessarily be based on the perceived demand characteristics of museums but could be based on the degree to which it interested the individual. Shirey and Reynolds (1988) noted that in the absence of specific externally set tasks, readers tend to focus on information that they find interesting. Koran et al. (1989), found that there was a significant positive relationship between how interesting subjects found a particular exhibit to be and viewing time. If, after scanning the exhibit, subjects are not interested, they will not be motivated to learn, and mental effort will not be expended on the particular exhibit, regardless of perceived demand characteristics of museums. Instead, they will continue to the next exhibit where the sequence will again be initiated. If a particular exhibit is found to be

interesting and the visitor is motivated to learn, then mental effort will be invested based on perceived museum demand characteristics.

When individuals choose to attend to an exhibit, the amount of effort required to comprehend the exhibit information may come into conflict with the motivating factors that bring visitors to informal learning centers. Recreation, relaxation, and entertainment are frequently cited as the main reasons for people visiting an informal learning center. Having to invest too much effort for learning may impinge upon these goals. Thus, it could be hypothesized that visitors arriving at informal learning centers have an *a priori* amount of effort that they are willing to expend on learning. Encountering an exhibit that is perceived as demanding would not necessarily result in increased amounts of effort being invested. Instead, the visitor may invest the predetermined amount of effort or bypass the exhibit. Once bypassed, the visitor will continue to search for exhibits where the effort required for comprehension matches the amount of effort they wish to invest. Exhibit characteristics such as labels with either a large number of words or fine print may imply a high level of difficulty thereby affecting the likelihood that the exhibit will be attended to by visitors.

If visitors arrive with an *a priori* amount of effort that they are willing to expend on learning, there is no reason to predict any relationship between perceived demand characteristics of museums and effort. The effect of visitors' unwillingness to invest more than a predetermined amount of effort on the relationship between perceived demand characteristics of museums may be compounded by Shirey and Reynolds' (1988) findings. They noted that readers invested less effort when learning things they believed to be interesting. Thus, visitors attending to exhibits that they find interesting are choosing to attend to exhibits that take less effort to comprehend. This finding would also imply that a limit is being placed on the amount of effort invested, since exhibits felt to be uninteresting would also be the exhibits from which learning is believed to be effortful. It is these effortful, uninteresting exhibits to which visitors fail

to attend. It could be hypothesized that a visitor in an informal learning setting would invest effort independent of the overall perceived museum demand characteristics but on an exhibit by exhibit basis.

An individual, in a free choice setting, whose desire to learn is internally motivated, arrives with a predetermined amount of effort that he/she is willing to invest. In the absence of external motivation, there is no reason to predict a relationship between perceived museum demand characteristics and learning. The failure to note a significant relationship between perceived museum demand characteristics and effort for the interest treatment group supports the hypothesis regarding the relationship between perceived demand characteristics of museums and invested effort. Subjects in the interest treatment group were given instructions to write down something interesting they noticed about each exhibit. As this task did not call for effortful behavior, the invested effort was independent of their perceived demand characteristics of museums.

However, subjects in the main point and look treatment groups showed a negative relationship between perceived demand characteristics of museums and invested effort. For all treatment groups, as subjects' perceived demand characteristics increased, the perceived difficulty of their tasks increased. In the absence of external motivation, subjects may be unwilling to invest effort in tasks that are believed to be difficult. Thus, subjects in treatment groups which did not allow the visitor to focus exclusively on information deemed interesting, invested a decreasing amount of effort as perceived demand characteristics of museums increased.

If visitors are placing a limit on the amount of effort they are willing to invest in learning from museum exhibits, then perceived demand characteristics of museums would have a much smaller influence on achievement than predicted by Salomon (1984). In this study, perceived demand characteristics of museums were only significantly and positively related to subjects' perceptions of task difficulty and subjects' posttreatment museum demand characteristics. Perceived demand

characteristics of museums were neither directly nor indirectly positively related to learning.

Salomon (1983) also stated that increasing the amount of invested mental effort results in greater learning. No significant relationship was noted between effort and learning in this study. As Shirey and Reynolds (1988) equated increased effort with increased time on task, the relationship between effort and time on task was investigated in this study. A significant positive relationship between invested effort and time spent on task was noted only for subjects in the main point treatment group. For all other treatment groups, the amount of time spent on task did not change with increasing invested effort. The interaction between treatment and invested effort, in regard to time on task, may be a function of the criteria an individual uses when deciding which exhibits will be attended to and for how long.

Shirey and Reynolds (1988) noted that adult learners better learned interesting information without any extra expenditure of effort, and that more time was spent when information was viewed as less interesting. However, in informal learning centers, visitors have been found to devote increasing amounts of time to exhibits as their interest level increases (Koran, Foster & Koran, 1989). Thus, it could be hypothesized that in museum settings, visitors are spending more time attending to exhibits which place lower demands on effort investment. Subjects in the look, interest, and text treatment groups, in the absence of specific instructions to attend to the components of the exhibit and determine the main points of the exhibit or text, would be more likely to spend time on items or objects that they found interesting. Mean effort invested by these subjects, in dealing with a series of exhibits, would not be a reliable predictor of time spent on task. One possible explanation could be that subjects who were given specific instructions to attend to all of the exhibit components and to determine the main points of the exhibit spent more time on exhibits that they did not perceive as interesting

and which demanded a greater amount of invested effort. In such case, a positive relationship between time and effort would be expected.

The functional significance of the relationship between subjects' report of invested effort and time on task appears questionable. Firstly, there was no direct relationship between effort expended and any achievement measure. Secondly, time on task was not significantly related to high level subtest score. Thirdly, when comparing scores, subjects in the main point treatment group did not score significantly different on the low level subtest than did subjects in any other treatment group.. Although increased effort resulted in increased time on task for the main point treatment group, when examining achievement as a function of time on task, the mean score for the main point treatment group was not significantly different from any other treatment group. If subjects in the main point treatment group had invested significantly more effort in learning from the museum exhibits than subjects in any other group who spent a similar amount of time on task, one would expect, that they would have scored significantly higher than subjects in other treatment groups. This assumption is based on Salomon's (1984) hypothesis concerning the relationship between effort and achievement.

In summary, findings from this study concerning perceived demand characteristics of a learning source, subject report of effort expended on task and perceived difficulty of the task would not support Salomon's AIME theory concerning learning. The failure to note a positive relationship between perceived demand characteristics, effort expended and achievement may be due to the differences between learning in formal and informal settings. The free choice nature of an informal learning setting, combined with the effects of visitor motivation and interests, radically affects the relationship between perceived demand characteristics, invested mental effort and learning.

Effect of Instructions

Researchers examining the effect of instructions on achievement have noted that instructions to summarize text or lecture material at periodic intervals have resulted in a decreased ability to successfully answer questions calling for synthesis, application and analysis. However, in regard to the ability to successfully answer questions that call for recall and recognition of information, it has been noted that all study methods that require some amount of attention be given to the material may be equally effective, especially in situations where individuals spend the same time, studying the same material (Annis, 1985). In light of these findings, it was hypothesized that there would be no significant treatment effect in regard to the low level subtest scores and that subjects in the main point treatment group would score significantly lower on the high level subtest.

No significant difference was expected between treatment group scores on the subtest of recall and recognition questions (low level subtest); however, a significant treatment effect was found to exist. Subjects in the main point treatment group scored significantly higher than all other treatment groups on the low level subtest. The same trend was noted when controlling for the effect of verbal fluency, associative memory, and scores on the test of hidden figures. It was predicted, based on learning from text, that subjects in this study would perform equally well on the low level subtest independent of treatment. This prediction was based on the assumption that all subjects were paying some amount of attention to the material.

However, in informal settings one cannot be sure that attention is being paid to material relevant to the learning goals of the exhibit. In this study, subjects in the look, interest, and text treatment groups were given instructions that did not encourage them to exclude irrelevant information contained in the exhibits or exhibit transcripts. In contrast, subjects in the main point treatment group were given instructions which specifically called for them to read the text of the exhibit, examine the objects and make

judgments concerning the relative importance of statements within exhibit labels. In carrying out this task, all of the information drawn upon to create the recall and recognition questions would have been encountered. For all other treatment groups, the absence of externally set task demands may have created a learning environment where subjects imposed the goal of entertainment and focused on the rich visual nature of the learning media. Therefore, subjects that are given the externally set goal of finding the main point of each exhibit could have been predicted to score higher on the low level processing subtest.

The absence of any treatment effect on the ability to successfully answer recall and recognition questions, as noted in Annis (1985), may have been due to the fact that all subjects were aware of a posttest. The external motivation provided by knowledge of a posttest has been demonstrated to positively affect achievement (Fire, 1985). When subjects are unaware of a posttest, differences in learning from text, as a result of instructions to take notes versus read only, are similar to the treatment effects found in this study regarding scores on the low level subtest. Glover et al. (1981) found, when comparing subjects' ability to recall idea units from a text, that subjects who were instructed to paraphrase each paragraph of text recalled a significantly greater number of idea units when compared to individuals who simply read the text. Subjects' recall of idea units is comparable to answering questions which call for knowledge and comprehension of exhibit material.

Subjects in the main point treatment group were predicted to score significantly lower on the high level subtest than all other treatment groups. This prediction was based on findings by Annis (1985). Annis found, when comparing the performance of students who read only, wrote down notes in their typical manner, and students who wrote paragraph summaries, that subjects in the paragraph summary treatment group scored significantly lower on synthesis and evaluation questions. Annis suggested that the time constraint of reading and then summarizing material left subjects with little time

or motivation to relate new material to existing schemata. In contrast, individuals who took notes when they wished or read only, evenly divided their time and effort between paying attention, encoding, and association.

In this study, however, when scores on the high level subtest were compared, no significant difference were noted between treatments. Without the knowledge of an impending posttest, it would appear that subjects in the text, interest, and look treatment groups did not expend the effort needed to integrate information across exhibits. Subjects in the main point treatment group, having invested time and effort in reading the exhibits and summarizing the main points, may have opted not to invest further time and effort to integrate information across exhibits. Given the possible unwillingness of subjects to invest effort in exhibit content integration, one would not predict any significant difference between treatment groups regarding scores on the high level subtest.

Aptitude Treatment Interactions

The reader will recall that verbal fluency, associative memory, hidden figures test score, and task preference were hypothesized to interact with treatment when examining the low and high level subtests. In this study, no interaction was found to exist between treatment and associative memory in regard to either the low or high level subtest. Instead, this researcher only noted a positive relationship between associative memory and total test score and low level subtest score. Associative memory did not account for a significant amount of the variance in test scores on both the high and low level subtests when controlling for verbal fluency, scores on the hidden figures test, and associative memory. These findings are similar to results reported by Masson and Miller (1983). These researchers concluded that measures of learners' ability to store verbal information are not powerful determinants of text processing ability for normal adult readers.

Treatment was noted to interact with learner task preference, when examining scores on the low level subtest. The effect of task preference on the low level subtest was limited to subjects in the main point treatment group. As subjects in the main point treatment group increasingly preferred to work on tasks that they set for themselves, their success in answering knowledge and comprehension questions decreased. There was no significant relationship between learner task preference and low level subtest score for the look, interest or text treatment groups. The negative relationship between task preference and score on the low level subtest for subjects in the main point treatment group is congruent with findings by Domino (1968). Domino noted that individuals at the achievement via conformity end of his bipolar scale performed optimally in settings which were typified by clearly defined assignments, a high degree of self-discipline, and where efficiency and responsibility were rewarded. Individuals at the achievement via independence end performed optimally in situations which rewarded independence, individuality, self-reliance, and creative innovation.

In this study, subjects in the main point treatment group were asked to carry out a task which had specific expectations. This task also took significantly more time than any other treatment and called for a high degree of self-discipline. Therefore, it is not surprising that subjects in this treatment group who preferred to have tasks set for them would out perform subjects who preferred to work on internally set tasks.

The treatment interactions regarding posttreatment museum demand characteristics are also of interest in this study. Although all treatment groups showed a positive relationship between pre- and posttreatment museum demand characteristics, the slope for describing this relationship was less than .78 for all treatment groups. Thus, after treatment, subjects' perceived demand characteristics of museums decreased independent of treatment. This decrease was the most drastic for subjects who read a transcript of the museum exhibits. The mean posttreatment perceived museum demand characteristics for subjects in the text treatment group was 38% of the mean

pretreatment perceived museum demand characteristics. It would appear that reading a text reinforced subjects' perceptions of museums as easy.

Conclusion and Implications for Future Research

An examination of the effects of visitor perceived demand characteristics and encoding cues on learning from museum exhibits served to reinforce (a) the differences between learning in informal settings and formal settings; (b) the effect that simple instructions have on learning outcomes; and, (c) the value of considering both learner aptitudes and the processing demands that test questions place on the learner. Verbal fluency, disembedding ability, and subject task preference had significant effects on achievement outcomes.

Researchers investigating the effects of learner perceptions of demand characteristics of text, television, and exhibit mock-ups used in formal learning settings have shown that as learners increasingly perceive an information source as difficult, they subsequently devote more effort to encoding the information and, therefore, learn more. In contrast, in this study, as visitors perceived learning in museum settings to be increasingly difficult, they were less likely to invest effort in learning from them.

This study examined learning from 11 static case exhibits. The topics addressed in these exhibits were all related to Florida natural history. Interest ratings for each exhibit varied widely between individuals and on average. Exhibit interest has been demonstrated to be an important predictor of time spent in front of an exhibit. Shirey and Reynolds (1988) noted that adult learners learned interesting information better without any extra expenditure of effort. Thus, it would appear that in museum settings, visitors are spending more time at exhibits that have lower demands on effort investment. Subjects in the look, interest, and text treatment groups did not show any relationship between time and effort. Subjects in the main point treatment group, who

were called upon to interact with each exhibit, regardless of its perceived interest, showed a positive relationship between time and effort.

Salomon's (1984) arguments concerning demand characteristics and amount of invested mental effort also hinge upon a positive relationship between increasing demand, effort and achievement. These arguments have been supported by research in which subjects did not have the option of moving on to another program, exhibit or text topic. In a free choice environment, such as a museum, it appears that when the medium is perceived to be difficult to learn from, or when individual exhibits are perceived as uninteresting, little time or effort will be expended to learn.

Future research investigating the effects of perceived difficulty and interest may wish to also incorporate the perceived difficulty of individual exhibits and the characteristics that visitors are using to determine difficulty. The organization and amount of text included, the number of objects within an exhibit and the degree to which the text varies from page format may effect visitors' perceptions of difficulty of particular exhibits, and thus influence the degree of interaction with an exhibit and willingness to invest effort. In a free choice environment, even visitors who arrive prepared to invest effort to realize personal learning goals may still bypass or spend minimal effort on exhibits when they are believed to be too complex, difficult or dull. The cumulative effect of too many difficult or dull exhibits, could weaken the relationship between perceived museum demand characteristics and effort.

Subjects in this study were specifically not informed that they would be tested on exhibit content in an effort to minimize any external motivation for learning and to maintain the free choice aspect of informal learning settings. In an informal learning environment, all time and effort invested in learning is strictly internally motivated. Subjects in the main point treatment group were given an external task to carry out that focused them on exhibit content but did not encourage synthesis of information across exhibits. Instructions which focused subjects on the salient features of museum

exhibits appear to have placed time constraints on subjects. Subjects in the main point treatment group, who scored significantly higher on questions calling for recall, did not score significantly different on questions calling for synthesis, analysis and application of information. It could be that subjects did not have the time or motivation to associate new material with existing schemata. In future research efforts, it may be of interest to provide instructions which make subjects aware of impending posttests. Investigations which include instructions that encourage subjects to associate information across exhibits would also be of interest.

Continued investigation of the effect of scores on the hidden figures test as they relate to learning in informal settings would also be recommended to provide insight into what exactly the test of hidden figures is measuring. Hidden figures test scores have been associated with an individual's ability to; superimpose knowledge structures on new information, disembed relevant information from an irrelevant background, restructure new information into manageable "chunks," and successfully address questions that call for problem solving. All of these abilities would result in a positive relationship between hidden figures test scores and achievement. However, it is also of interest to note the relatively low correlations noted between the hidden figures test scores and verbal fluency; .26 in this study and .13 between hidden figures test and score on the wide range vocabulary test as noted by Spiro and Tirre (1980).

It is crucial to consider the level of processing that achievement test questions call for when making generalizations regarding the effects of treatment and learner abilities. Table 5-1 illustrates how the relationship between achievement and treatment (Treat), time on task (Time), hidden figures test score (HFT), verbal fluency (Verbal), associative memory (Assoc), Museum Demand Characteristics (MDC) and task preference (Task), would vary if only high or low level processing subtests or if total test score was considered. Use of achievement tests that address various levels of

learning can result in the failure to note treatment effects and aptitude treatment interactions.

Table 5-1
Variation in Experimental Relationships as a Function of Test and Predictor Variable

Test	Treat.	Time	HFT	Verbal	Assoc.	MDC	Task
Total	none	none	Main/+	Main/+	Main/+	none	Main/-
High	none	none	Main/+	Main/+	none	none	Main/-
Low	yes	Main/+	TRT/+	TRT/+	TRT/+	none	ATI

NOTE: ATI = aptitude treatment interaction, TRT = treatment effect
 + = positive relationship, - = negative relationship

Results from this study demonstrate that significant learning occurs in museum settings. Providing subjects with instructions to summarize exhibit content resulted in significantly higher scores on a subtest composed of recall and recognition questions. However, when examining subjects' ability to answer questions calling for synthesis, analysis and application of exhibit information, this study would suggest that reading text is just as effective a learning method as a visit to an informal learning center. The amount of learning that occurs in informal settings may have been underestimated by this researcher and other researchers examining learning in informal settings as a function of the assumptions made when carrying out this line of research. Although the assumptions described below played an integral role in this study to evaluate learning from museum exhibits, they may be of reduced importance when considering a more global view of learning in informal settings.

First, the researcher assumed that there would be congruence between the institution's goals for the exhibit and visitors' goals in terms of stimuli attended to and how learners choose to integrate information. Visitors to an informal learning center may not arrive with the goal of learning all that is possible about a particular topic. Rather, a visitor may enter an informal learning center to satisfy the goal of being entertained and will then selectively attend to information that is found to be interesting. The information gained is not necessarily organized into the structure foreseen by the exhibit curators. Therefore, test questions are not effective in measuring achievement. Also, by virtue of the achievement test, information that is not relevant to exhibit objectives, but that may be of interest to learners, is deemed unimportant.

The researcher also placed a qualitative value on information that is gained by visitors and the level to which that information is processed. Prior knowledge has been shown to be a strong predictor of learning (Staver & Jacks, 1988). However, this study did not take visitor prior knowledge into account. Knowledge and comprehension levels of learning may be significant for individuals who lack prior knowledge of subject areas. Thus, given the level of prior knowledge on the part of the visitor, any learning may be significant.

Also, the researcher did not consider the affective domain in this study beyond surveying subjects' views as to how fun museums were perceived to be. The mean response to the statement "It is more fun to visit a museum than it is to read a book," was between strongly agree and agree. Overall, this view showed no significant change due to treatment. This study suggests that reading a text is just as effective a way for college students to process information as a visit to an informal learning center. However, the likelihood that an individual will voluntarily pick up a book on the same subject that a museum exhibit addresses remains an unknown quantity. Informal learning centers may have a significant effect on individuals' attitudes toward a subject and learning in general. Learning is a lifelong process and most of that learning occurs

in informal settings. The fact that learning in these settings is viewed as enjoyable and actively sought out may compensate for disparities between exhibit objectives and visitor learning.

GLOSSARY

- Amount of invested mental effort - The number of nonautomatic, effortful elaborations applied to a unit of material. Reliably measured by use of self report (Salomon 1983, 1984).
- Aptitude - Any characteristic of the learner which facilitates or interferes with learning from some designated instructional method (Koran & Koran, 1984).
- Aptitude-treatment interaction - A situation where one instructional treatment or methodology is significantly better for one type of student while another treatment favors a differently type of student. (Koran & Koran, 1984).
- Associative memory - A measure of short term memory capacity.
- Attention - Selectively focusing on a specific stimuli to the exclusion of other stimuli.
- Attracting power - A ratio between the number of people who stop and attend to an exhibit and the total number of people who pass by an exhibit.
- Disembedding ability - In reference to flexibility of closure, the ability to hold a given visual percept or configuration in mind as to disembed it from other well defined perceptual material (French et al, 1976).
- Elaboration - relating, analyzing and associating new material to stored knowledge
- General ability - A term used to refer to measures of intelligence, scholastic aptitude, and verbal and nonverbal reasoning tests (Koran & Koran, 1984)
- Holding power - The total amount of time a visitor spends attending to an exhibit.
- Informal learning settings - Environments where the individual is intrinsically motivated to attend to stimuli, activities are self directed and individuals are free to choose which stimuli to attend to and for how long.
- Perceived demand characteristics - Predispositions, attitudes or attributions of a source of information that affect how much effort is devoted to comprehension.

APPENDIX A MATERIAL FOR TEXT TREATMENT GROUP

The material composing the text is a word for word transcription of the 11 exhibits that were viewed by subjects in the look, interest and main point treatment groups.

Mammal Invasions and Introductions in Florida

Natural invasion occurs when a climatic or other barrier is removed, when a species through evolution overcomes a limiting factor or when populations increase markedly. Most introductions are non-native mammals brought in by man intentionally.

Nine banded armadillo (Dasypus novemcinctus). The nine banded armadillo is here because of natural movement and introduction by man. Several animals escaped near Titusville in 1924 when a circus truck overturned and in 1936 when a hurricane blew a circus apart. Their descendants now live throughout the peninsula and are still progressing west and north. Populations that originally invaded Texas from Mexico in the 1800's are invading the Florida panhandle from the west.

House mice (Mus musculus), Norway rats (Rattus norvegicus) and Black rats (Rattus rattus) native to Europe and Asia, probably arrived in America in the ships of the earliest European settlers. They all can either live in the wild or in buildings. In the same barn, the heavy, short tailed Norway rat uses the floor space and the slender blackrat (with a long tail for balancing) inhabits the rafters and beams.

Four red bellied squirrels (Sciurus aureogaster) were introduced on Elliot Key in 1938. No native squirrels were present in the jungle like forest on that island and the

exotics are now abundant. The wide salt water barrier should prevent natural invasions into the Florida mainland.

Historically, domestic pigs (*Sus scrofa*) were allowed to run on open range in Florida. A single rancher's hog range (alloted by local political arrangement) could be as large as an entire county. The pigs were rounded up for market periodically, but not all were captured. Today some are released intentionally and managed by the state as a game resource.

Beaver (*Castor canadensis*) were common in Northern and Central Florida until the late 1800's. Overharvesting nearly eliminated the species from the state; a few panhandle populations may have survived. Reintroduction and natural movement from Alabama and Georgia are re-establishing beaver here.

Coyotes (*Canus latrans*) and black tailed jackrabbits (*Lepus californicus*) are released in Florida by persons who hunt with greyhounds. The coyotes are reproducing in the wild in Northern Florida and the jackrabbits are very common at the Miami International Airport and North Miami and may be spreading along roadside "prairies," recently one was found in Tampa.

The South American Nutria (*Myocaster coypu*) was imported as a fur animal. When it became apparent that the aquatic rodent's fur had little use, ranchers all over the United States released their animals or sold them to be stocked in freshwater marshes. Nutria were widespread in Florida until the 1950's, but have declined for unknown reasons and now occur only in a few places.

The large Sambar deer (*Cervus unicolor*) was introduced to St. Vincent Island in 1900. Sambar are unusual among deer in being grazers (grass eaters) as well as browsers (twig eaters). They have prospered at St. Vincent largely through their grazing ability. The Gulf waters have been an effective barrier against dispersal to the mainland.

Wild (feral) populations of rhesus monkeys (Macaca mullata) have been established at Loggerhead Key and near Ocala, at Silver Springs and the Oklawaha River. Squirrel monkeys (Siamiri sciurus) are living at Crystal River. Free ranging populations at Silver Springs and Miami Monkey Jungle may depend on supplemental feeding.

American Bison (Bison bison) first entered the Southeastern United States in the late 1500's. Their spread through grassy, open areas was promoted by clearing and burning by American Indians and European settlers. Bison were hunted as far south as Tampa Bay, but were eliminated from the Southeast by 1800. Two were killed east of Gainesville on August 13, 1716 and 3 were killed 7 days later near Ichetucknee Springs.

Genetic Variation in Mammals

Though all animals of the same kind have common characteristics, they are never identical. Many obvious variations are known to be the result of inherited (genetic) factors.

Individual Variation - color and size of individuals may vary within a population. If environmental differences are not involved, the variation can be assumed to be the result of genetic differences. The range of variation in fox squirrels from North Central Florida is a good example of inherited individual variation

Sexual Variation - color and size of individuals often differs according to sex. These variations are known to be the result of genetic differences which are inherited.

Variations among populations - subspecies - All interbreeding populations have characteristic features. If a portion of such a population becomes isolated, the two resulting populations may develop different features. These populations may then be recognized as distinct subspecies. Examples of this include subspecies of the plains

pocket gopher (Geomys bursarius), gray squirrels (Sciurus carolinensis) and beach mice (Peromyscus polionotus).

Variation among populations - species When isolated populations change substantially, they may become separate species. Several species of cottontail rabbits (Sylvilagus) illustrate variations among species. Two of these, the marsh rabbit and eastern cottontail live in adjacent habitats in Florida (both occur on the University of Florida campus).

Two subspecies breed with one another where they are in geographic contact. By contrast, two species cannot interbreed even though they may live in the same place.

Florida: Land or Sea?

Limestone teeming with invertebrate fossil outcrops in most parts of Florida. Shark teeth, dugong ribs, porpoise ribs and vertebrae are some of the common marine fossils in sand and clay deposits. These fossils show that Florida was under the ocean at various times in the past:

The right lower jaw (mandible) of a Balaenoptera, an extinct baleen whale from Middle Pliocene Bone Valley Formation. 10 Million years old. (Polk County).

Fossil marine invertebrates from the Gainesville region. They are Eocene (50 million years old) and Miocene (20 million years old).

Ribs and vertebrae from extinct porpoises that lived near what is now Gainesville during the late Miocene Hawthorn Formation (20 million years old).

Dugong ribs, common Florida vertebrate fossils --- these are found in the Gainesville region and are from the late Miocene Hawthorn Formation (20 million years old).

Fossil shark teeth from creeksands in and near Gainesville. They are late Miocene Hawthorn Formation (20 million years old).

What do paleontologists do with the evidence? By mapping the extent of each rock formation and determining the age of the fossils in each, the relative positions of land and sea during Florida's long history can be reconstructed.

For hundreds of millions of years, Florida lay completely submerged. About 50 million years ago, as sea levels dropped, islands began to appear on, in and around Gainesville. Since that time major fluctuations in sea levels and uplifts of the land masses have repeatedly changed Florida's shorelines. The greatest extent of Florida's exposed land surface occurred during the Ice Ages (a time of alternating climatic cycles). At times, vast amounts of rainwater were frozen into thick glaciers across the Northern Continents. During one such glacial period, the world's seas were lowered by at least 400 feet and Florida occupied twice the area that it does now. During the last 30 thousand years (a warmer period) seas have risen to the present level.

Tropical Ice Age Mammals

A great variety of mammals lived in Florida during the Ice Ages or Pliocene. The 128 known species of Ice Age mammals of Florida may be grouped in five ways.

Many Ice Age mammals (62 species) became extinct at the end of the Pliocene; examples are giant ground sloth, giant beaver, mammoth, mastodon, and the saber-tooth tiger. Horses also died out.

Many Ice Age mammals (42 species) continued to live in Florida; bobcat, beaver, black bear, yellow bat, white tailed deer, otter and cotton rat.

A few Ice Age mammals (6 species) vanished from Florida at the end of the Pliocene, but survived north of the state in temperate North America; examples are the North American porcupine, northern muskrat, bog lemming, meadow vole and grey bat.

A few other Ice Age mammals (5 species) also vanished from Florida at the end of the Pliocene but their nearest relatives survive in arid Western America; examples

are bison, coyote, jackrabbit, and pronghorn antelope.

The 13 remaining species of Ice Age mammals vanished from Florida at the end of the Pliestocene and their nearest relatives survive only in tropical America; examples are vampire bat, South American porcupine, capybara, spectacled bear, hognose skunk, ocelot, jaguar, jaguarundi, tapir, peccary and llama.

Florida shared warm tropical conditions and many tropical species of mammal with other Caribbean islands before the Pliestocene epoch or Ice Ages. Even when glaciers blanketed the Great Lakes region and extremely cold winters struck temperate parts of the world, Florida's subtropical climate continued and its tropical species survived. Near the end of the Pliestocene, the northern Caribbean climate also became to severe for many of these species.

The Formation of Fossils

Fossils are the preserved remains, impression or traces of plants and animals of past geologic ages. Because natural processes tend to work against it, fossilization of entire animals occurs only under special conditions.

Internal molds reflect internal structures. They are formed when an embedded specimen's interior is filled with sediments that harden. When the outer shell or layer dissolves or breaks away, the internal mold is exposed.

External molds are formed when a shell or other part is hidden in sedimentary deposits and then dissolved by groundwater leaving behind an exact impression of the original object.

Casts are formed when natural molds are filled with a mineral substance that hardens and reflects the shape of the original specimen.

Unaltered remains, under very special conditions, parts of some organisms endure without any change to the original material.

Carbonization occurs when the organic material slowly decomposes under water or in sediment leaving behind only a film or a residue of carbon in the form of the original specimen.

Petrification involves the replacement, particle by particle, of the original substance of the specimen. This is a chemical process.

Permineralization occurs when minerals from groundwater fills voids in specimens that are porous, such as bone or some types of shells. The objects original shape is preserved.

Incomplete petrification - the enclosing rock has been silicified, whereas the fossil echinoid has retained its carbonate composition.

Invertebrate Fossils and Their Living Counterparts

Fossils are not necessarily remains of extinct forms of life. For example, many fossils preserved in Florida's rocks have living counterparts. Shells of modern sea animals and their fossil relatives may even be found side by side on certain beaches.

Fossils from older rocks are less likely to have living relatives. On the average, animal species last about a million years and much of Florida is geologically younger than this. By studying the living animals we can often make inferences about environments of the fossil forms.

Freshwater Clams and Snails of the Gulf Coast Region

Some organisms occur in a variety of habitats over large geographic areas. Others are more restricted. Biologists often find patterns in distribution that help explain a regions geological, geographical and ecological history.

Locally endemic forms - The Gulf Coast region of Florida and neighboring parts of Alabama and Georgia harbor a rich assortment of aquatic animals. Many are restricted in distribution (endemic) to this region. Some mollusks occur only in single

ivers and their tributaries or even small segments of a particular river. Some snails are confined to a single spring.

Regionally Endemic - Some other mollusks are more widely distributed within this region and occur in several or more streams in lakes in Florida and adjacent states.

Widely distributed forms - A third group of freshwater mollusks that occur in Florida consists of species that are widely distributed in Eastern United States. They tolerate a wider variety of ecological conditions.

Important Clues to Bird Identification

The identification of a specific bird by an amateur bird watcher or serious ornithologist can be much easier when the bird's distinctive features are used as clues.

Silhouettes provide many clues: Are the wings long or short, broad or narrow, rounded or pointed at the tips, slotted or unslotted at the tips? Are the wings leading edges straight, curved or angular? How far does the head protrude beyond the body? How long is the tail? Do the feet protrude beyond the tail?

Is the body held vertically, horizontally or at an angle? Is the tail elevated or held horizontally? Is the head crested? Is there a small head on a large body, a large head on a small body or a small head on a slender body?

Size is an important character:

Ruby throated hummingbird - very small

Carolina wren - small

Cardinal - medium

Fish crow - large

Tail Shape is a distinctive character:

Cliff swallow - short, notched

Barn swallow - deeply forked

Purple martin - moderately forked

Red bellied woodpecker - stiff, with pointed tail feathers

American robin - squared

Blue jay - rounded

Morning dove - long and pointed

What is the shape of the bill:

American Greenwinged teal - flattened

Brown creeper - slender and probe-like

Meadowlark - straight

Red cockaded woodpecker - straight and sturdy, chisel-like

Common snipe - long

Yellow throated warbler - slender and needlelike

American kestrel - sharply hooked

Blue grosbeak - heavy and conical

Chimney Swift - short

Are feet webbed for swimming, adapted for walking on the ground or perching in trees? Do they have special adaptations for climbing or grasping prey? Exact structure may be difficult to see but foot color is sometimes an important characteristic.

A red eyed vireo and a hooded warbler - most species having descriptive names do have observable features of color, pattern, shape or habit. But common names can be misleading. Some birds' names are based solely on the appearance of adult males in breeding plumage. Others are based on features that are hidden or too small to notice. Some names exaggerate (as with the greenwinged teal and redwinged blackbird), still others have nothing to do with the bird's actual appearance.

Color differences within a species are important; between make and female and between immature birds and adults. Summer and winter plumages may also be different.

Color and color patterns are among the most important and most used clues. Certain color features provide immediate identification; such as two white outer tail feathers of the vesper sparrow, the black mask of the loggerhead shrike, and the neckbands of the killdeer, piping plover and semipalmated plover. Bill and foot colors are also important.

Identifying Birds by Their Behavior and Their Places in Environments

Every species has a habitat preference and its own behavioral characteristics. Illustrated here are common resident birds encountered in mixed pine and broad leaved Florida forest.

Feeding behaviors of many species of bird are quite distinctive.

Several species glean leaves for insects but move differently: Yellow throated warblers move slowly and deliberately; Parula warblers and yellow throated vireos make rapid flitting movements.

While hunting, red tailed hawks soar and American kestrels hover and pursue over open fields. Coopers hawks dart deftly and rapidly thru open spaces in the forest.

Aerial soaring and pursuit of insects, or hawking, by birds that do not perch between catches is a characteristic behavior of chimney swifts, purple martins and nighthawks.

Great crested flycatchers, Acadian flycatchers and Wood peewees sally forth and hawk for insects and return to their perches between

A species is usually found in a specific habitat:

Forest canopy; yellow throated vireo, yellow throated warbler, summer tanager.

Forest subcanopy; red eyed vireo, wood peewee.

Short tree/shrub layer; white eyed vireo, carolina wren, acadian flycatcher.

Thicket or Forest Edge; brown thrasher, indigo bunting.

Forest Floor; rufous sided towhee.

On the Ground near Forest Edge; bobwhite.

Open Fields; meadowlark.

Some species may be found in more than one place or more than one level in its habitat, but certain places always seem to be preferred. For example, cardinals in open stretches in a forest and its edges; pileated woodpeckers on the largest tree trunks; red bellied woodpeckers on medium sized tree trunks and large limbs; and downy woodpeckers always on small tree trunks and small limbs.

The voice of a bird may often be the only indication that it is present. Examples include those birds that stay in thick underbrush or are nocturnal:

Carolina wren - usually hidden in thick underbrush.

Barred owl, screech owl, chuckwills widows and woodcocks usually move about only at night.

Poisonous Snakes of Florida

Though most Florida snakes are harmless, a few are dangerous. All have certain markings by which they can be separated from non-poisonous species. All poisonous snakes should be avoided.

Except for the way they procure their food, poisonous snakes are identical to all other snakes in their lifestyle, ecology and biology.

Eastern Diamondback Rattlesnake (Crotalus admanteus). The rattles may be used to make a buzzing warning, but not necessarily. The triangular head, diamond pattern, tail rattles, and pit between each eye and nostril distinguish this dangerous snake from any harmless snake.

Pigmy Rattlesnake (Sistrurus miliarius). This small venomous serpent, often called a ground rattler, has dark patches on a light gray background often with irregular orange markings. It has a triangular head and a pit between each eye and nostril. Notice the differences between it and the harmless southern hognose snake that often appears dangerous by its head and neck flattening, hissing, puffing up and head thrusting movements.

Copperhead (Agkistrodon contortrix). Copperheads have comparatively slender bodies, triangular heads, a pit between each eye and nostril and a pinkish brown color with darker markings. Because of their superficial resemblance to the cottonmouth, copperheads are occasionally called upland moccasins.

Coral Snake (Micrurus fulvius). This dangerous snake has a black nose and black, yellow and red bands that go all the way around the body. The color pattern distinguishes this highly poisonous snake from the scarlet kingsnake and scarlet snake, both of which are harmless.

Cottonmouth Moccasin (Agkistrodon piscivorus). The cottonmouth moccasin, usually found in or near water has a thick body, dark dull pattern, triangular head and a pit between each and nostril. When alarmed it may open its mouth, showing the white lining. The harmless banded water snake and several other watersnakes are confused with it.

Canebrake Rattlesnake (Crotalus horridus). This is a close relative of the timber rattlesnake of the northern uplands. It is heavy bodied, with a comparatively small triangular head. The light brown body with darker chevron markings are characteristic.

The effects of snake poisons vary, depending upon the size and species of the snake, the amount of poison injected, the size and nature of the bite and the age and health of the bitten animal. Some venoms affect the functioning of the nervous system and respiratory systems; others attack the circulatory system by destroying the lining of the blood vessels, blood cells and blood clotting mechanisms. Most venoms move through the intercellular spaces and pass through the tissues rather than following nerves or blood vessels. Tissue damage is occasionally extensive and serious bacterial infections (gangrene) may be involved. Venoms are particularly dangerous to individuals who happen to be sensitive to the foreign proteins they contain; for them, such bites can cause death or serious illness.

Poisonous snakes may have several hollow fangs in each jaw; but only one on each side is functional. The others are held in reserve until the worn fang is shed. Worn fangs are usually lost during feeding. Coral snakes have fixed fangs--the fangs of vipers (all other Florida poisonous snakes) swing backwards when the mouth is closed.

Interesting Amphibians and Reptiles of Florida

Over 200 forms (species and subspecies) of amphibians and reptiles occur in Florida. All have unusual body forms and/or behavior that allow them to survive in diverse environments. Several Florida species illustrate the extraordinary variety of lifestyles in these vertebrates. Some are found nowhere else in the world.

Greater Siren (*Siren lacertina*), this eel-like salamander's single pair of legs, bushy gills, and stout body distinguish it from other aquatic amphibians.

Little Grass Frog (*Limnoaedus ocularis*), at 1/2 inch, this is the smallest frog in North America and one of the smallest vertebrates in the world. In Florida it often breeds in roadside ditches throughout the year. Its cricket-like call is so high and shrill that some persons have difficulty hearing it.

Southeastern Blind Salamander (Haideotriton wallacei), these blind salamanders live their entire lives in certain western Florida caves. They are highly adapted for living in these unique environments.

Alligator Snapping Turtle (Macrolemmys temmincki), the aquatic alligator snapper entices fish into its open mouth by wagging a wormlike appendage. The fleshy lure is fastened in the middle by a short stalk arising from the floor of the mouth. This is especially effective in murky water.

Florida Worm Lizard (Rhinura floridana), these primitive lizards are mainly restricted to Florida where they burrow in sandy soil. Tiny body scales are arranged in segment like rings, leading to their being mistaken for earthworms.

Sand Skink (Neoseps reynoldsi), this small burrowing lizard occurs only in a few localities in central Florida. It moves through the sand with its tiny legs against its body, undulating like a snake. It pushes sand out of the way with its flattened spade-like head.

Florida Soft Shelled Turtle (Trionyx ferox), the flattened body, streamlined head, strongly webbed feet and powerful legs of these aquatic turtles enable them to swim rapidly, often against currents. The skin covered shells of the soft shell turtles are flexible because they are partly bone and partly cartilage. All other freshwater turtles have rigid and well developed bony shells covered with non-living scales.

Southern Black Racer (Coluber constrictor), many snakes vibrate their tails when cornered; in dead leaves the sound is similar to that made by rattlesnakes. Sounding like a rattler may have its advantage.

Cottonmouth Moccasin (Agkistrodon piscivorus), a young cottonmouth uses its yellow tail as a lure. Small lizards and frogs attracted to the waving tail provide a source of food. As the snake matures the bright tail color disappears.

Eastern Glass Lizard (*Ophiosaurus ventralis*), although superficially resembling a snake, this reptile is a legless lizard. Unlike snakes, lizards have eyelids, external ear openings and often, the ability to lose their tails. The glass lizard was so named because its tail may break in many places. The writhing, twisting tail segments draw the attention of the would-be predator away from the body and head.

Green Anole (*Anolis carolinensis*), the color of these lizards can change with their changing emotional state. They are usually bright green when feeding or defending their territory and brown or gray when they are at rest or cold.

Southern Ringneck Snake (*Diadophis punctatus*), this small secretive snake can elevate and coil its tail to reveal a bright red underside. The tail coiling occurs when the snake is attacked by a predator. The caudal display may serve to draw the assailant's attention away from the snake's head.

Eastern Hognose Snake (*Heterodon platyrhinos*), when disturbed, this snake spreads its head and neck, hisses loudly and makes threatening movements. If this fails, it writhes violently, gasps and turns over belly up -- a behavior that has been called "death feigning" -- though it is not known how it is stimulated. The hognose snake is completely harmless.

Barbour's Map Turtle (*Graptemys barbouri*) males of this freshwater species are smaller and have more slender heads than females. These sexual differences match differences in feeding habits, for males eat aquatic soft bodied insects. While females, using their large powerful jaws, eat snails and clams.

APPENDIX B
MUSEUM DEMAND CHARACTERISTICS TEST AND SELF-REPORT ITEMS

Note that spacing between items has been compressed in order to conserve space.

Name _____

Please circle the response that best fits the way you feel.

1. My main reason for going to a museum is to be entertained:
a. strongly disagree b. disagree c. not sure d. agree e. strongly agree
2. Compared with learning from texts, learning from museum exhibits is:
a. very difficult b. difficult c. not difficult d. easy e. very easy
3. It is more fun to visit a museum than it is to read a text
a. strongly disagree b. disagree c. not sure d. agree e. strongly agree
4. Compared with learning from a lecture, learning from museum exhibits is:
a. very difficult b. difficult c. not difficult d. easy e. very easy
5. I am better at learning from museum exhibits than texts.
a. strongly disagree b. disagree c. not sure d. agree e. strongly agree
6. I prefer learning from texts relative to learning from museum exhibits.
a. strongly disagree b. disagree c. not sure d. agree e. strongly agree
7. I have a harder time learning from texts than museum exhibits.
a. strongly disagree b. disagree c. not sure d. agree e. strongly agree
8. I put a lot of effort into learning from the museum exhibits
a. strongly disagree b. disagree c. not sure d. agree e. strongly agree
9. The assignment I carried out at the museum was:
a. very difficult b. difficult c. not difficult d. easy e. very easy

The next question is based on a 1-15 scale. Where 15 represents the strongest preference for working on tasks set by yourself and 1 represents the strongest preference for working on requirements that are set for you. Please circle the number which most clearly corresponds with your beliefs about yourself.

"I do my best work when
I can set tasks for myself"

"I do my best work when I am
meeting requirements set for me"

15 14 13 12 11 10 9 8 7 6 5 4 3 2 1

APPENDIX C
ACHIEVEMENT TEST

Please note that spacing between test items was compressed to conserve space.

INSTRUCTIONS - Please answer each question. If you are not sure of your answer, please do not guess. Once finished with a question, do not go back. Thank you.

1. Organisms that have been released intentionally or unintentionally into a new environment by man are said to be _____.
2. Which characteristic would be most useful in identifying a bird in flight, at a distance? _____.
3. Give the common name of one bird that was mentioned in the exhibit, "Identifying Birds by their behavior and Their Places in the Environment."

4. The color pattern of a coral snake is:
_____.
5. By what criterion is the habitat in the Bird Behavior exhibit divided into different niches? _____
6. Two reptiles in Florida use part of their body to lure prey to them.
Write down the common names of these two species.

7. Organisms with a limited geographic distribution are said to be:
_____.
8. Most of Florida is geologically younger than _____ years.
9. What external characteristic(s) distinguishes rattlesnakes, copperheads and cottonmouth moccasins from non-poisonous snakes?
_____.
10. Which lizard found in Florida lacks legs? _____

11. An example of an animal that is in Florida due to unintentional actions of humans is _____.
12. Organisms that have naturally migrated into an area are described as having _____.
13. The chemical replacement of the original substance of a specimen in fossilization is referred to as _____.
14. Two types of fossils used to prove Florida was once underwater are _____
_____.
15. A dugong resembles which living Florida species? _____.
16. The climate in Florida during most of the Pleistocene was _____.
17. When natural molds fill with a mineral substance that hardens and reflects the shape of an organism you have a _____.
18. What characteristic of fox squirrels was offered as an example of genetic variation in mammals? _____.
19. Fossil plants are most likely to be preserved through which process _____.
20. Two examples of animals that were once found in Florida but are now extinct in Florida with related species in South America are _____
_____.
21. List three characteristics, other than color and silhouette, that can be useful in identifying a bird _____

_____.
22. During which time period was Florida's land mass greater than it is today? _____.
23. One can infer many things from the shape and size of a bird's foot. Two things you can infer are:

_____ or
_____.

24. Of the 128 known species of Pleistocene mammals found in Florida, the majority of them are

- a. Still found in Florida
- b. Still found in North America
- c. Carnivores
- d. Still found in South America
- e. Extinct
- f. Still found in the Caribbean
- g. Small in size

25. The replacement, particle by particle, of the original substance of a specimen is known as

- a. petrification
- b. carbonization
- c. permineralization
- d. casting

26. A freshwater mollusk that is found in Florida and is also found throughout the Eastern United States could be referred to as:

- a. a locally endemic form
- b. a regionally endemic form
- c. a widely distributed form
- d. a different species.

27. What would probably happen to the introduced population of Sambar deer if the Earth went through another Ice Age:

- a. The population would go extinct
- b. The population would invade mainland Florida
- c. The population would not change
- d. The population would crossbreed with White Tailed Deer

28. What best describes a comparison between genetic variation in subspecies and genetic variation in species?

- a. neither subspecies of species can naturally interbreed
- b. subspecies cannot naturally interbreed but species can
- c. sub species can naturally interbreed but species cannot
- d. both subspecies and species can naturally interbreed

29. Which statement best compares Florida's land mass now with Florida's land mass during the Ice Ages?

- a. Florida is smaller now than during the Ice Ages
- b. Florida is the same size now as during the Ice Ages
- c. Florida is larger now than during the Ice Ages
- d. Paleontologists do not know how they compare

30. Compare the fate of the horse and the black bear in Florida as the end of the Pleistocene

- a. both survived
- b. the horse went extinct
- c. the black bear went extinct
- d. both went extinct

31. Animals may arrive in an area either by the process of invasion or the process of introduction. In the following examples circle which process best describes the following situations.

a. Cattle egret appear in the United States after being blown off course by a storm.
Invasion Introduction

b. Bison move into Florida after woodlands are burned by man to create pasture for raising cattle. Invasion Introduction

c. Blind snakes from Asia are found in South Florida in the soil in pots containing imported plants. Invasion Introduction

d. Sparrow hawks are found in Mexico after Sparrow hawk populations in Texas show a great increase in numbers. Invasion Introduction

32. Your friends, in a paleontological frenzy, dig a five foot hole in their backyard. They give you the following data concerning fossils they found and how deep under the surface they were found.

_____	soil surface
llama bone, peccary bone	_____
_____	1 foot below
dugong bones	_____
_____	2 foot below
mastodon ribs	_____
_____	3 foot below
scallop and conch shells	_____
_____	4 foot below
jaguarundi bone	_____
spectacled bear bone	_____
_____	5 foot below

Using this data, what could you infer about the geological history of the area your friend lives in?

Is it possible your friend lives in Gainesville, Florida? Why?

33. Both the Florida Sand Skink and the Worm Lizard are similar in shape and lifestyle. What are these similarities? What can you infer about the lifestyle of Glass Lizard from these similarities?

34. Identify which fossilization process (if any) was carried out to create the specimens in front of you.

1. mold 2. cast 3. unaltered remains 4. carbonization
5. petrification 6. permineralization

Specimen A _____

Specimen B _____

Specimen C _____

35. Sand skinks are an endemic species and are presently found only in the central sandhill regions of Florida. The species evolved 50 million years ago. Given your understanding of Florida's geological history how would you explain its limited distribution?

If a population of sandskinks was discovered on Key Biscayne, in South Coastal Florida how would you explain the discovery?

36. Color variation in animals may be due to environmental differences or genetic differences. The origin of these differences is being investigated in three populations of lizards.

Lizards are first observed in the wild, where diet varies with population and day/night length varies seasonally. In the laboratory, lizards from each population are kept at constant temperature and a constant day/night cycle of 12 hours light/12 hours dark, all fed on mealworms and kept separate from lizards from the other two populations. Lizards from each population are bred for three generations. The color characteristics for each population (wild and third generation captive) are as follows:

Color as a function of Population

	Wild	Population 1 Captive	Wild	Population 2 Captive	Wild	Population 3 Captive
Males (summer)	red	red	green	red	orange	orange
(winter)	blue	red	black	red	brown	brown
Females (summer)	blue	blue	black	blue	brown	brown
(winter)	blue	blue	black	blue	brown	brown
Juveniles (s)	yellow	yellow	beige	yellow	olive	olive
(w)	yellow	yellow	beige	yellow	olive	olive

Diet as a function of Population

	Population 1	Population 2	Population 3
Wild	Grasshoppers	Caterpillars	Grasshoppers
Captive	Mealworms	Mealworms	Mealworms

Using the information from the previous page, answer the following questions by circling the correct answer.

Circle the difference which may account for the difference between populations 1 and 2:
Environmental Genetic

Circle the difference which may account for the difference between populations 1 and 3:
Environmental Genetic

Circle the difference which may account for the difference between populations 2 and 3:
Environmental Genetic

Circle the difference which may account for the differences between males and females in any of the populations:
Environmental Genetic

Circle the difference which may account for the differences between wild and captive males of population 1: Environmental Genetic

Which population (s) is most likely to be considered a species or subspecies
_____. Why?

37. Picture of an Emerald Tree Boa

In your continued journeys in Madagascar, you discover the snake pictured above. Again, you have left your field guide to reptiles of Madagascar at home to leave room for beer in your backpack. Would you conclude that this snake is related to rattlesnakes, copperheads and water moccasins? Why?

Would you want any further information? If so, what would that be?

APPENDIX D

R-SQUARED VALUES FOR ALL SIGNIFICANT MODELS

Outcome Variable	Model	R ²
Time	Time = Trt	.50
	Time = Trt X Effort ATI	.53
Effort	Effort = Trt X MDC ATI	.15
Task Difficulty	Task Difficulty = MDC	.04
	Task Difficulty = Trt X Time ATI	.09
Posttreatment MDC	Post MDC = Time Trt Effect	.05
	Post MDC = Effort X Trt ATI	.13
	Post MDC = MDC X Trt ATI	.36
Total Test Score	Total Test = Verbal Fluency	.19
	Total Test = Associative Memory	.03
	Total Test = HFT	.09
	Total Test = Time	.06
	Total Test = HFT + Verbal Fluency + Associative Memory	.25
High Level Subtest Score	High Level = HFT	.06
	High Level = Task Preference	.02
	High Level = Verbal Fluency	.04
	High Level = HFT + Verbal Fluency + Associative Memory	.09
Low Level Subtest Score	Low Level = Verbal Fluency Trt Effect	.25
	Low Level = HFT Trt Effect	.06
	Low Level = Associative Memory Trt Effect	.06
	Low Level = MDC Trt Effect	.03
	Low Level = Trt X Task Preference ATI	.08
	Low Level = Time	.10

APPENDIX E
MULTIPLE REGRESSION SUMMARY TABLES FOR MAIN EFFECTS

Table E-1
The Effect of Museum Demand Characteristics (MDC) on Perceived Difficulty of Task

Source	DF	SS	MS	F	Prob > F
Model	1	5.3	5.3	6.274	.0134
Error	146	123.7	0.8		
Parameter Estimates					
Variable	DF	Parameter Estimate	SE	T	Prob > T
Intercept	1	1.94	0.28	6.939	.0001
MDC	1	0.06	0.02	2.505	.0134

Table E-2
The Effect of Verbal Fluency on Total Test Score

Source	DF	SS	MS	F	Prob > F
Model	1	2138.0	2138.0	35.505	.0001
Error	147	8851.9	60.2		
Parameter Estimates					
Variable	DF	Parameter Estimate	SE	T	Prob > F
Intercept	1	14.1	2.20	6.399	.0001
Verbal Fluency	1	0.52	0.09	5.959	.0001

Table E-3
The Effect of Associative Memory on Total Test Score

Source	DF	SS	MS	F	Prob > F
Model	1	433.6	433.6	6.038	.0152
Error	147	10556.3	71.8		
Parameter Estimates					
Variable	DF	Parameter Estimate	SE	T	Prob > F
Intercept	1	21.7	2.11	10.320	.0001
Associative Memory	1	0.25	0.10	2.457	.0152

Table E-4
The Effect of Hidden Figures Score on Total Test Score

Source	DF	SS	MS	F	Prob > F
Model	1	1062.5	1062.5	15.733	.0001
Error	147	9927.4	67.5		
Parameter Estimates					
Variable	DF	Parameter Estimate	SE	T	Prob > F
Intercept	1	21.4	1.48	14.416	.0001
Hidden Figures	1	0.41	0.10	3.967	.0001

Table E-5
The Effect of Time on Task on Total Test Score

Source	DF	SS	MS	F	Prob > F
Model	1	757.0	757.0	10.192	.0017
Error	164	12,180.8	74.3		
Parameter Estimates					
Variable	DF	Parameter Estimate	SE	T	Prob > F
Intercept	1	21.80	1.55	14.006	.0001
Time	1	0.13	0.04	3.193	.0017

Table E-6
The Effect of Hidden Figures Test Score, Verbal Fluency, and Associative Memory on Total Test Score

Source	DF	SS	MS	F	Prob > F
Model	3	2840.8	946.9	16.85	.0001
Error	139	7811.7	56.2		
Parameter Estimates					
Variable	DF	Parameter Estimate	SE	T	Prob > F
Intercept	1	8.9	2.69	3.327	.0011
Hidden Figures	1	0.28	0.10	2.808	.0057
Verbal Fluency	1	0.44	0.09	4.703	.0001
Associative Memory	1	0.16	0.10	1.663	.0985

Table E-7
The Effect of Hidden Figures Score on High Level Subtest

Source	DF	SS	MS	F	Prob > F
Model	1	162.1	162.1	10.2	.0018
Error	146	2331.5	15.97		
Parameter Estimates					
Variable	DF	Parameter Estimate	SE	T	Prob > F
Intercept	1	8.2	0.72	11.383	.0001
Hidden Figures	1	0.16	0.05	3.187	.0018

Table E-8
The Effect of Verbal Fluency on High Level Subtest Score

Source	DF	SS	MS	F	Prob > F
Model	1	127.3	127.3	7.854	.0058
Error	146	2366.3	16.02		
Parameter Estimates					
Variable	DF	Parameter Estimate	SE	T	Prob > F
Intercept	1	7.2	1.15	6.244	.0001
Task Preference	1	0.13	0.04	2.803	.0058

Table E-9

The Effect of Subject Task Preference on High Level Subtest Score

Source	DF	SS	MS	F	Prob > F
Model	1	60.69	60.69	3.642	.0583
Error	146	2433.0	16.67		
Parameter Estimates					
Variable	DF	Parameter Estimate	SE	T	Prob > F
Intercept	1	12.1	0.99	12.189	.0001
Task Preference	1	-0.19	0.10	-1.980	.0583

Table E-10

The Effect of Hidden Figures Test Score, Verbal Fluency, and Associative Memory on High Level Subtest Score

Source	DF	SS	MS	F	Prob > F
Model	3	262.6	87.5	5.631	.0013
Error	139	2160.8	15.5		
Parameter Estimates					
Variable	DF	Parameter Estimate	SE	T	Prob > F
Intercept	1	4.9	1.41	3.492	.0006
Hidden Figures	1	0.13	0.05	2.478	.0144
Verbal Fluency	1	0.09	0.05	1.810	.0724
Associative Memory	1	0.07	0.05	1.428	.1556

Table E-11
The Effect of Time on Task on Low Level Subtest Score

Source	DF	SS	MS	F	Prob > F
Model	1	627.0	627.0	20.181	.0001
Error	164	5095.5	31.1		
Parameter Estimates					
Variable	DF	Parameter Estimate	SE	T	Prob > F
Intercept	1	12.1	1.005	12.026	.0001
Task Preference	1	0.12	.0264	4.492	.0001

APPENDIX F
MULTIPLE REGRESSION SUMMARY TABLES FOR TREATMENT EFFECTS

Table F-1
The Effect of Treatment on Time on Task

Source	DF	SS	MS	F	Prob > F
Model	3	19892	6630	49	.00001
Error	144	19461	135		

Parameter Estimates

Variable	DF	Parameter Estimate	SE	T	Prob > F
Intercept	1	23.05	1.86	12.385	.0001
Main point	1	30.16	2.73	11.057	.0001
Text	1	2.55	2.75	0.930	.3537
Interest	1	13.97	2.58	5.407	.0001

Treatment Comparisons

Main point and Text		Test	DF	F Value	Prob > F
Numerator		12758	1	94	.0001
Denominator		135	144		
Main point and Interest		Test	DF	F Value	Prob > F
Numerator		4920	1	36	.0001
Denominator		135	144		
Text and Interest		Test	DF	F Value	Prob > F
Numerator		2409	1	18	.0001
Denominator		135	144		

Table F-2
The Effect of Treatment on Low Level Subtest Score

Source	DF	SS	MS	F	Prob > F
Model	3	252.7	84.2	2.682	.0587
Error	145	4831.9	33.3		
Parameter Estimates					
Variable	DF	Parameter Estimate	SE	T	Prob > T
Intercept	1	15.23	0.91	16.681	.0001
Main point	1	3.48	1.35	2.585	.0107
Text	1	0.70	1.36	0.515	.6073
Interest	1	0.70	1.28	0.552	.5820
Treatment Comparisons					
Main point and Text	Test	DF	F	Prob > F	
Numerator	129.6	1	3.8884	0.0505	
Denominator	33.3	145			
Main point and Interest	Test	DF	F	Prob > F	
Numerator	144.9	1	4.3493	.0388	
Denominator	33.3	145			
Text and Interest	Test	DF	F Value	Prob > F	
Numerator	.00035	1	0.0000	.9974	
Denominator	33.3	145			

Table F-3

The Effect of Treatment on Low Level Subtest Score, Controlling for Verbal Fluency

Source	DF	SS	MS	F	Prob > F
Model	4	1379.6	344.9	13.405	.0001
Error	144	3704.9	25.7		

Parameter Estimates

Variable	DF	Parameter Estimate	SE	T	Prob > T
Intercept	1	6.77	1.51	4.484	.0001
Verbal Fluency	1	0.38	0.06	6.618	.0001
Main point	1	2.11	1.20	1.758	.0808
Text	1	-0.83	1.21	-0.681	.4967
Interest	1	-0.04	1.13	-0.038	.9695

Treatment Comparisons

Main point and Text	Test	DF	F	Prob > F
Numerator	144.7	1	5.6242	.0190
Denominator	25.7	144		
Main point and Interest	Test	DF	F	Prob > F
Numerator	86.7	1	3.3707	.0684
Denominator	25.7	144		
Text and Interest	Test	DF	F Value	Prob > F
Numerator	11.27	1	0.4380	.5092
Denominator	25.7	144		

Table F-4
The Effect of Treatment on Low Level Subtest Score, Controlling for Associative Memory

Source	DF	SS	MS	F	Prob > F
Model	4	449.9	112.5	3.494	.0093
Error	144	4634.7	32.2		

Parameter Estimates

Variable	DF	Parameter Estimate	SE	T	Prob > T
Intercept	1	11.99	1.59	7.562	.0001
Associative Memory	1	0.17	0.07	2.475	.0145
Main point	1	3.61	1.32	2.728	.0072
Text	1	0.55	1.34	0.415	.6786
Interest	1	0.37	1.26	0.297	.7667

Treatment Comparisons

Main point and Text	Test	DF	F	Prob > F
Numerator	155.6	1	4.8342	.0295
Denominator	32.1	144		

Main point and Interest	Test	DF	F	Prob > F
Numerator	193.1	1	5.9990	.0155
Denominator	32.1	144		

Text and Interest	Test	DF	F Value	Prob > F
Numerator	0.6	1	0.0185	.8920
Denominator	32.1	144		

Table F-5
The Effect of Treatment on Low Level Subtest Score, Controlling for Hidden Figures
Test Score

Source	DF	SS	MS	F	Prob > F
Model	4	454.1	113.5	3.530	.0088
Error	144	4630.5	32.2		

Parameter Estimates

Variable	DF	Parameter Estimate	SE	T	Prob > T
Intercept	1	13.30	1.18	11.259	.0001
HFT	1	0.18	0.07	2.502	.0135
Main point	1	2.67	1.36	1.960	.0520
Text	1	0.13	1.35	0.092	.9265
Interest	1	0.29	1.26	0.231	.8180

Treatment Comparisons

Main point and Text		Test	DF	F	Prob > F
Numerator		107.9	1	3.3544	.0690
Denominator		32.1	144		
Main point and Interest		Test	DF	F	Prob > F
Numerator		104.7	1	3.2548	.0733
Denominator		32.1	144		
Text and Interest		Test	DF	F Value	Prob > F
Numerator		0.5	1	0.0158	.9000
Denominator		32.1	144		

APPENDIX G
MULTIPLE REGRESSION SUMMARY TABLES FOR APTITUDE TREATMENT
INTERACTIONS

Table G-1

The Interaction between Museum Demand Characteristics (MDC) and Treatment on
Subject Report Effort Expended on Task

Source	DF	SS	MS	F	Prob > F
Model	7	19.96	2.85	3.445	.0020
Error	141	116	0.83		

Parameter Estimates

Variable	DF	Parameter Estimate	SE	T	Prob > T
Intercept	1	4.67	0.51	9.08	.0001
MDC	1	-0.14	0.03	-3.64	.0004
Main point	1	-0.37	0.78	-0.478	.6331
Text	1	-1.24	0.74	-1.664	.0984
Interest	1	-1.55	0.79	-1.954	.0527
MDC X Main point	1	0.04	0.06	0.665	.5074
MDC X Text	1	0.14	0.06	2.375	.0189
MDC X Interest	1	0.13	0.06	1.997	.0477

Treatment Comparisons

Main point and Text	Test	DF	F Value	Prob > F
Numerator	1.955	1	2.3624	.1265
Denominator	0.828	141		
Main point and Interest	Test	DF	F Value	Prob > F
Numerator	1.346	1	1.6267	.2043
Denominator	0.828	141		
Text and Interest	Test	DF	F Value	Prob > F
Numerator	0.0143	1	0.0173	.8956
Denominator	0.8278	141		

Table G-2

The Interaction between Subject Report of Effort Expended on Task and Treatment on Time Spent on Task

Source	DF	SS	MS	F	Prob > F
Model	7	23292.1	3327.5	25.017	.0001
Error	154	20483.5	133.0		

Parameter Estimates

Variable	DF	Parameter Estimate	SE	T	Prob > T
Intercept	1	25.2	5.74	4.389	.0001
Effort	1	-0.72	1.88	-0.381	.7037
Main point	1	13.38	8.32	1.607	.1101
Text	1	3.26	9.10	0.358	.7209
Interest	1	12.89	8.38	1.539	.1259
Main point X Effort	1	5.55	2.65	2.090	.0382
Text X Effort	1	-0.23	2.77	-0.084	.9328
Interest X Effort	1	0.61	2.73	0.222	.8245

Treatment Comparisons

Main point and Text	Test	DF	F	Prob > F
Numerator	580.1	1	4.3612	.0384
Denominator	133.0	154		
Main point and Interest	Test	DF	F	Prob > F
Numerator	437.0	1	3.2853	0.0718
Denominator	133.0	154		
Text and Interest	Test	DF	F Value	Prob > F
Numerator	11.6	1	0.0875	0.7677
Denominator	133.0	154		

Table G-3

The Interaction between Time Spent on Task and Treatment on Subject Self of Task Difficulty

Source	DF	SS	MS	F	Prob > F
Model	7	12	1.74	2.183	.0385
Error	157	126	.80		

Parameter Estimates

Variable	DF	Parameter Estimate	SE	T	Prob > T
Intercept	1	1.86	0.34	5.42	.0001
Time	1	0.03	0.01	2.08	.0388
Main point	1	2.07	0.62	3.34	.0011
Text	1	0.04	0.70	0.07	.9458
Interest	1	1.00	0.54	1.82	.0700
Time X Main point	1	-0.05	0.02	-3.05	.0027
Time X Text	1	0.001	0.03	0.04	.9661
Time X Interest	1	-0.04	0.02	-2.24	.0364

Treatment Comparisons

Main point and Text	Test	DF	F Value	Prob > F
Numerator	3.42	1	4.2758	.0403
Denominator	0.80	157		
Main point and Interest	Test	DF	F Value	Prob > F
Numerator	0.54	1	0.6776	0.4117
Denominator	0.80	157		
Text and Interest	Test	DF	F Value	Prob > F
Numerator	1.97	1	2.4625	.1186
Denominator	0.80	157		

Table G-4
Effort Expended on Task and Treatment on Posttreatment Museum Demand
Characteristics (MDC)

Source	DF	SS	MS	F	Prob > F
Model	7	301.15	43.02	3.302	.0026
Error	156	2032.34	13.03		

Parameter Estimates

Variable	DF	Parameter Estimate	SE	T	Prob > T
Intercept	1	20.42	1.80	11.374	.0001
Effort	1	-2.17	0.58	-3.683	.0003
Main point	1	-2.66	2.57	-1.037	.3014
Text	1	-7.76	2.84	-2.728	.0071
Interest	1	-7.59	2.65	-2.865	.0047
Effort X Main point	1	0.80	0.81	0.980	.3287
Effort X Text	1	2.21	0.86	2.557	.0115
Effort X Interest	1	2.19	0.86	2.549	.0118

Treatment Comparisons

Main point and Text	Test	DF	F Value	Prob > F
Numerator	36.53	1	2.8038	.0969
Denominator	13.03	156		
Main point and Interest	Test	DF	F Value	Prob > F
Numerator	1.346	1	2.7608	.0986
Denominator	13.03	156		
Text and Interest	Test	DF	F Value	Prob > F
Numerator	0.005	1	0.0004	.9844
Denominator	13.03	156		

Table G-5

The Interaction between Pretreatment Museum Demand Characteristics (MDC) and Treatment on Posttreatment Museum Demand Characteristics

Source	DF	SS	MS	F	Prob > F
Model	7	779	111.29	11.403	.0001
Error	139	1357	9.76		
Parameter Estimates					
Variable	DF	Parameter Estimate	SE	T	Prob > T
Intercept	1	5.11	1.78	2.89	.0045
MDC	1	0.71	0.13	5.29	.0001
Main point	1	-1.09	2.68	-0.41	.6850
Text	1	3.67	2.57	1.43	.1551
Interest	1	-1.53	2.84	-0.54	.5903
MDC. X Main point	1	0.07	0.21	0.35	.7252
MDC X Text	1	-0.38	0.20	-1.93	.0552
MDC. X Interest	1	0.09	0.23	0.38	.7053
Treatment Comparisons					
Main point and Text		Test	DF	F Value	Prob > F
Numerator		43.63	1	4.4707	.0363
Denominator		9.75	139		
Main point and Interest		Test	DF	F Value	Prob > F
Numerator		0.03	1	0.0029	.9574
Denominator		9.75	139		
Text and Interest		Test	DF	F Value	Prob > F
Numerator		38.94	1	3.9909	.0477
Denominator		9.75	139		

Table G-6
The Interaction Between Task Preference and Treatment on Low Level Subtest Score

Source	DF	SS	MS	F	Prob > F
Model	7	457.6	65.4	2.064	.0506
Error	154	4876.8	31.7		

Parameter Estimates

Variable	DF	Parameter Estimate	SE	T	Prob > T
Intercept	1	12.56	2.53	4.972	.0001
Task Preference	1	0.26	0.26	0.993	.3221
Main point	1	11.10	3.56	3.138	.0020
Text	1	3.56	3.60	0.989	.3242
Interest	1	3.39	3.66	0.926	.3561
Main point X Preference	1	-0.80	0.35	-2.265	.0249
Text X Preference	1	-0.29	0.38	-0.781	.4357
Interest X Preference	1	-0.26	0.37	-0.689	.4917

Treatment Comparisons

Main point and Text	Test	DF	F	Prob > F
Numerator	62.58	1	1.9761	.1618
Denominator	31.68	154		
Main point and Interest	Test	DF	F	Prob > F
Numerator	1574.8	1	49.7283	.0001
Denominator	31.68	154		
Text and Interest	Test	DF	F Value	Prob > F
Numerator	0.3416	1	0.0108	.9174
Denominator	31.68	154		

REFERENCES

- Abrahamson, D., Gennaro, E., & Heller, P. (1983a). Animal exhibits: A naturalistic study. Museum Education Roundtable: Roundtable Reports, 8, 6-9.
- Abrahamson, D., Gennaro, E., & Heller, P. (1983b). Visitor behavior at open and closed animal exhibits. Museum Education Roundtable: Roundtable Reports, 8, 10-14.
- Annis, L. F. (1985). Student generated paragraph summaries and information processing theory of prose learning. Journal of Experimental Education, 54, 4-10.
- Beer, V. (1987). Great expectations: Do museums know what visitors are doing? Curator, 30, 206-215.
- Bitgood, S., & Benefield, A. (1987). Visitor behavior: A comparison across zoos (Tech. Report No. 86-20). Jacksonville, Alabama: Jacksonville State University, The Psychology Institute.
- Bitgood, S., Nichols, G., Pierce, M., Conroy, P., & Patterson, D. (1986). Effect of label characteristics on visitor behavior. (Tech. Report No. 86-55). Jacksonville, Alabama: Jacksonville State University, The Psychology Institute..
- Bitgood, S., Nichols, G., Pierce, M., & Patterson, D. (1986). The effects of instructional signs on museum visitors. (Tech. Report No. 86-70). Jacksonville, Alabama: Jacksonville State University, The Psychology Institute.
- Bitgood, S., Pierce, M., Nichols, G. & Patterson, D. (in press). Formative evaluation of a cave exhibit. Curator.
- Brennan, T. (1977). Typical zoo visitor social group behavior. AAZPA National Conference Proceedings 1977, 109-116.
- Carter, C.S., LaRussa, M.A., & Bodner, G.M. (1987). A study of two measures of spatial ability as predictors of success in different levels of general chemistry. Journal of Research in Science Teaching, 24, 645-657.
- Chandran, S., Treagust, D.F., & Tobin, K. (1987). The role of cognitive factors in chemistry achievement. Journal of Research in Science Teaching, 24, 145-160.
- Cheek, N.H. (1976). Some social-psychological aspects of going to the zoo: Implications for educational programming. AAZPA Regional Conferences Proceedings, 1975-76, 317-323.

- Cronbach, L.J., & Snow, R.E. (1981). Aptitudes and instructional methods: A handbook for research on interactions. New York: Irvington Publishers, Inc.
- Diamond, J. (1986). The behavior of family groups in science museums. Curator, 29, 139-54.
- Dierking, L. D., Koran, J. J., Jr., Lehman, J., & Koran, M. L. (1984). Recessing in exhibit design as a device for directing attention. Curator, 27, 238-48.
- Domino, G. (1968). Differential prediction of academic achievement in conforming and independent settings. Journal of Educational Psychology, 59, 256-260.
- Einstein, G. G., Morris, J. & Smith, S. (1985). Note-taking, individual differences and memory for lecture information. Journal of Educational Psychology, 77, 522-532.
- Ekstrom, R.B., French, J.W., Harman, H.H., & Derman, D. (1976). Manual for kit of factor referenced cognitive tests. Educational Testing Service: Princeton, New Jersey.
- Falk, J. H., Koran, J. J., Jr., Dierking, L. D., & Dreblow, L. (1985). Predicting visitor behavior. Curator, 28, 249-257.
- Feher, E. & Rice, K. (1985). Development of scientific concepts through use of interactive exhibits in a museum. Curator, 28, 35-46.
- Field, D. E., & Anderson, D. R. (1985). Instruction and modality effects on children's television attention and comprehension. Journal of Educational Psychology, 77, 91-100.
- Fire, W. M. (1986). Interaction of cues, learner curiosity, verbal ability and amount of invested mental effort with achievement in a museum setting. (Doctoral dissertation, University of Florida, 1985). Dissertation Abstracts International, 47, 1269A.
- Gage, N. L. (1978). The scientific basis of the art of teaching (4th ed.) New York: Teachers College Press.
- Gennaro, E. (1981). The effectiveness of using previsit instructional materials on learning from a museum fieldtrip experience. Journal of Research in Science Teaching, 18, 275-279.
- Glover, J. A., Plake, B. S., Roberts, B., Zimmer, J. W., & Palmere, M. (1981). Distinctiveness of encoding: The effects of paraphrasing and drawing inferences on memory from prose. Journal of Educational Psychology, 73, 736-744.
- Glover, J. A., Plake, B. S., & Zimmer, J. W. (1982). Distinctiveness of encoding and memory for learning tasks. Journal of Educational Psychology, 74, 189-198.
- Greenglass, D. I. (1986). Learning from objects in a museum. Curator, 29, 53-66.

- Kellert, S. R. (1979). Zoological parks in American society. Proceedings of the AAZPA Annual Conference, 1979, 88-126.
- Kimche, L. (1978). Science centers: A potential for learning. Science, 199, 270-73.
- Kolar, J. R. (1980). Dinosaurs, Dodos and you. AAZPA Regional Workshop Proceedings, 1980, 95-101.
- Koran, J.J., Jr., Foster, J.S., & Koran, M.L. (1988). The relationship among interest, attention and learning in a natural history museum. In, S. Bitgood, J.T. Roper, & A. Benefield (Eds.), Visitor Studies: Theory, Research and Practice, Volume II (pp. 239-244). Jacksonville, Alabama: Center for Social Design.
- Koran, J. J., Jr., Koran, M. L., & Longino, S. J. (1986). The relationship of age, sex, attention and holding power of two types of science exhibits. Curator, 29, 227-235.
- Koran, J.J., Jr., Koran, M.L., & Foster, J.S. (1988). Individual difference in learning from informal settings. In, S. Bitgood, J.T. Roper, & A. Benefield (Eds.), Proceedings of the First Annual Visitor Studies Conference: Visitor Studies 1988, Theory, Research and Practice. (pp. 66-72). Jacksonville, Alabama: Center for Social Design.
- Koran, J. J., Jr., Lehman, J. R., Shafer, L. D., & Koran, M.L. (1983a). The relative effects of pre and postattention directing devices on learning from a "walk-through" museum exhibit. Journal of Research in Science Teaching, 20, 341-346.
- Koran, J. J., Jr., Longino, S. J., & Shafer, L. D. (1983b) A framework for conceptualizing research in natural history museums and science centers. Journal of Research in Science Teaching, 20, 325-339.
- Koran, J. J., Jr., Morrison, L., Lehman, J. R., Koran, M. L., & Gandara, L. (1984). Attention and curiosity in museums. Journal of Research in Science Teaching, 21, 357-63.
- Koran, M.L., & Koran, J.J., Jr. (1975). Interaction of learner aptitudes with question pacing in learning from prose. Journal of Educational Psychology, 67, 76-82.
- Koran, M.L., & Koran, J.J., Jr. (1984). Aptitude-treatment interaction research in science education. Journal of Research in Science Teaching, 21, 793-808.
- Laetsch, W. M., Diamond, J., Gottfried, J. L., & Rosenfeld, S. (1980). Children and family groups in science centers. Science and Children, 17, 14-17.
- Linn, M. C. (1980). Free choice experiences: How do they help children learn? Science Education, 64, 237-248.
- Lord, T.R. (1987). A look at spatial abilities in undergraduate women science majors. Journal of Research in Science Teaching, 24, 757-767.

- Masson, M. E. J., & Miller, J. A. (1983). Working memory and individual differences in comprehension and memory of text. Journal of Educational Psychology, 75, 314-318.
- Peart, B. (1984). Impact of exhibit type on knowledge gain, attitudes and behavior. Curator, 27, 220-237.
- Peper, R. J., & Mayer, R. E. (1986). Generative effects of note taking during science lectures. Journal of Educational Psychology, 78, 34-38.
- Pribyl, J.R., & Bodner, G.M. (1987). Spatial ability and its role in organic chemistry: A study of four organic courses. Journal of Research in Science Teaching, 24, 229-240.
- Salomon, G. (1983). The differential investment of mental energy in learning from different sources. Educational Psychologist, 18, 42-50.
- Salomon, G. (1984). Television is "easy" and print is "tough": The differential investment of mental effort in learning as a function of perceptions and attributes. Journal of Educational Psychology, 76, 647-658.
- Screven, C.G. (1974). The measurement and facilitation of learning in the museum environment: An experimental analysis. Washington, D.C.: Smithsonian Institution Press.
- Serrell, B. (1981a). Researching visitor response to museum exhibit labels. AAZPA Regional Conference Proceedings, 1981, 261-275.
- Serrell, B. (1981b). Zoo label study at Brookfield Zoo. International Zoo Yearbook, 21, 54-61.
- Shirey, L. L., & Reynolds, R. E. (1988). Effects of on attention and learning. Journal of Educational Psychology, 80, 159-166.
- Spiro, R. J., & Tirre, W. C. (1980). Individual differences during discourse processing. (1980). Journal of Educational Psychology, 72, 204-208.
- Staver, J.R., & Jacks, T. (1988). The influence of cognitive reasoning ability, cognitive restructuring ability, disembedding ability, working memory capacity, and prior knowledge on students' performance on balancing equations by inspection. Journal of Research in Science Teaching, 17, 763-775.
- Thier, H. D. (1984). Developing effective exhibits for the expanding role of museums. Curator, 27, 93-103.
- White, J., & Barry, S. (1984). Science education for families in informal settings on evaluation of the herplab project. (Tech. Report No. 86-45). Jacksonville, Alabama: Jacksonville State University, The Psychology Institute.
- White, S. C. (1983). Prepassage questions: The influence of structural importance. Journal of Educational Psychology, 75, 234-244.

- Witkin, H.A., Moore, C.A., Goodenough, D.R., & Cos, P.W. (1977). Field dependent and field independent cognitive styles and their educational implications. Reviews of Educational Research, 47, 1-64.
- Wright, E. L. (1980). Analysis of the effect of a museum experience on the biology achievement of 6th graders. Journal of Research in Science Teaching, 17, 99-104.

BIOGRAPHICAL SKETCH

John Scott Foster was born October 20, 1959, in Norfolk, Virginia. He attended Virginia Polytechnic Institute and State University from 1978 to 1982. Graduating magna cum laude, in honors, Mr. Foster was awarded a Bachelor of Science in biology. As four years of college came to a close, he did not foresee full-time employment as the next logical step in life. Having no wish to see snow again, Mr. Foster opted for graduate school at the University of Florida. He was awarded a Master of Science in zoology in December, 1985.

Realizing that human welfare was dependent upon the well being of biological diversity on Earth, Mr Foster set the career goal of becoming employed by a zoological park. Tenure in the zoology department made him realize, however, that wildlife conservation would only succeed if an enlightened public believed it to be a worthwhile endeavor. Having met the charismatic Dr. John J. Koran, Jr., Mr. Foster headed to the College of Education to pursue a doctoral degree.

Mr. Foster currently resides in Gainesville, Georgia (Poultry Capital of the World), with his wife, Karin. Employed at Elachee Nature Science Center since 1989, Mr. Foster has been learning how to put theory into practice and honing his skills of educating the masses. In his spare time, which will increase significantly ($p < .0001$) upon the completion of this document, he oversees operations at Bob's Python Ranch, North.

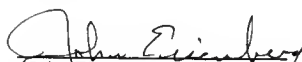
I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.


John J. Koran, Jr., Chairman
Professor of Instruction and
Curriculum

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.


Mary Lou Koran
Professor of Foundations of
Education

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.


John Eisenberg
Katharine Ordway Professor
of Ecosystem Conservation

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

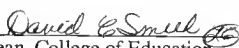

Eugene Todd
Professor of Instruction and
Curriculum

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.


Linda Jones
Associate Professor of
Instruction and Curriculum

This dissertation was submitted to the Graduate Faculty of the College of Education and to the Graduate School and was accepted as partial fulfillment of the requirements for the degree of Doctor of Philosophy.

May, 1992



Dean, College of Education

Dean, Graduate School

UNIVERSITY OF FLORIDA



3 1262 08554 6843